A STUDENT-CENTRED MATHEMATICS BOOKLET SYSTEM; ITS INFLUENCE ON STUDENT'S MATHEMATICAL PERFORMANCE AND ATTITUDE TO MATHEMATICS

by

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DECLARATION

Avondale College

Faculty of Education

DECLARATION

This thesis contains no material that has been accepted for the award of any degree or diploma in any university. To the best of my knowledge and belief, this thesis contains no material published or written by another person except where due reference is made in the text of the thesis.

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ABSTRACT

There are many approaches to teaching mathematics. This paper examines one student-centred approach called the Booklet System used by a number of secondary schools in Brisbane from the mid-1990's for about a decade. Claims made by those advocating this system include improved achievement in mathematics and a better attitude to mathematics in general.

Year 9 students in three schools were given a Pre Test at the beginning of the school year and a Post Test in the second last week of the school year. Two of these schools operated a traditional teacher-centred textbook system and one school used the student-centred Booklet System. All students participating in the study in the three schools also completed Attitude Questionnaires at the same time as the Pre Test and Post Test.

Statistical analysis revealed that the Booklet System is successful in improving a student's attitude about their own progress in Mathematics, but does not improve their attitude to homework or Mathematics in general. It is not surprising then that this study shows that the Booklet students do not achieve any better academically than the NonBooklet students.

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1 Introduction

For the past hundred years, teachers the world over have grappled with the daily challenge of getting their class interested in Mathematics. There are libraries of books on "how to teach", "how to motivate your class", and "how to get students interested in Mathematics". When a student is interested and keen there is an almost bottomless pit of energy and willpower that can sustain that student and take them to any level of achievement (in keeping with their talents).

It is possible, however, that the real root cause of student disinterest is that teacher's classes have been just that - TEACHER'S classes. The teacher took centre stage and in so doing, took all control and hence most of the enthusiasm and energy from the students.

For many years the traditional classroom, including Mathematics, has been one based upon this conventional, teacher-centred teaching. Teachers have had hammered into them through example and exhortation that they must learn the art of "presenting a lesson". Students accessed Mathematics through teacher explanations and textbook questions with regular text-based homework. However,

> Mathematics can no longer be regarded as a `chalk and talk' subject from the perspective of the teacher or as a `textbook, pencil and paper' subject from the perspective of the students . . . Creative solutions should be sought to ensure that each student experiences a mathematically rich environment. (Australian Education Council, 1990, p. 22,23)

1.1 Alternative Teaching Systems

Throughout the years a number of alternative teaching systems have been developed to enable students to learn. Most learning in the past has been derived either from the spoken word (from a teacher, for instance) or from the written word (usually in books). This is the traditional chalk-and-talk method. In the last few decades there has been cooperative

learning, discovery learning, investigation and problem solving, multiple intelligences, inquiry-based teaching, and many other approaches including combinations of pedagogical methods.

1.2 The Booklet System

A new Junior Mathematics program using a student-centred Booklet System (refer Appendix 1 for explanation) proposes that conventional, old traditional, explanatory teaching should be a small part in a different scheme of student centred learning. This program is an effort to stop teachers taking 'centre stage' and to give students more control, freedom and to give them a chance to make a personal commitment.

The Booklet System is a student-centred, mathematics learning centre involving an independent booklet learning program. This system was begun by a teacher, Bill O'Donnell, at a local private school in Brisbane in 1992. He placed no copyright on his system and allowed others schools to copy and reproduce his materials. The Booklet system has been operating in a few schools in Brisbane for a number of years. Bill is currently working in Brisbane for Hubbard Academy, an institution that offers tutorial-based assistance for students, and has refined his booklets over the years. In Years 8 to 10 at Northpine Christian College in Brisbane it was functioning from 1997 to 2004. It was also operating at two other schools in Brisbane before 2004.

The author of this paper would like to examine whether this program is more effective than the conventional teacher-centred teaching method. There are many claimed advantages of this particular Booklet System (see Appendix 2). If this new way of teaching mathematics is able to achieve even half of its stated goals then it will certainly be very useful.

To determine the impact of this Booklet System approach this study aims to examine its influence on students' attitudes to mathematics and students' achievement across a set of skills within the discipline of mathematics.

1.3 Research Question

This study aims to examine whether the Booklet System is more effective than the conventional teacher-centered and textbook teaching method in a Queensland Junior Secondary school mathematics classroom context.

The research process for this study is related to the following questions:

1. What is the student's 'attitude to mathematics' profile prior to a controlled classroom experience?
2. What is the student's 'attitude to mathematics' profile after a controlled classroom experience?
3. What are the student achievement ratings across a set of mathematics skills prior to a controlled classroom experience?
4. What are the student achievement ratings across a set of mathematics skills after a controlled classroom experience?
5. Does the classroom learning environment (Booklet System or conventional mathematics classroom – teacher and textbook) have an impact on student attitude and achievement in mathematics and is this impact different for different student ability levels?

2 Literature Review

2.1 Conceptual Framework: The Learning Environment

Research over recent decades has indicated that the learning environment in schools has an impact on student learning (Fraser, 1994 and 1998). Studies have shown that students' perception of the school learning environment account for significant amounts of variance in learning outcomes, in fact sometimes beyond that attributable to student characteristics (Goh and Fraser, 1998). Studies in Canada (O'Reilly, 1975) found that the learning environment in the mathematics classroom accounted for 67% of the variance of the achievement scores.

Rickards, Fisher and Fraser (2003), in their study of the learning environment, used a questionnaire on teacher interaction with scales such as student responsibility, student freedom, teacher leadership, teacher helping, teacher understanding behaviours and teacher admonishing behaviours. They indicate the following:-

> The scale reporting student responsibility and freedom in the classroom had a positive association with attitude to class and a negative association with achievement. This suggests that students enjoy the class more if they are given higher levels of student responsibility and freedom but **achieve better if they are not**. Cognitive achievement was higher where teachers demonstrated more leadership, helping / friendly and understanding behaviours and less strict, dissatisfied and admonishing behaviours. (p. 4)

One aspect of the learning environment that has received particular attention is the way males view the classroom as opposed to females. With respect to gender differences within the classroom environment, studies have shown that "females perceive their teachers in a more positive way than males" (Rickards et al, 2003, p. 7).

Another factor of the learning environment is the aspect of academic efficacy - ones perception of their capabilities to perform academic tasks.

> Research studies have provided consistent, convincing evidence that academic efficacy is positively related to academic motivation (e.g. Schunk & Hanson, 1985), persistence (Lyman et al, 1984), memory performance (Berry, 1987), and academic performance (Schunk, 1989). (Dorman et al, 2004)

The Booklet System, the focus of this study, is one particular learning environment and it was interesting to examine the impact this learning environment had on student attitudes and achievement.

2.2 Conceptual Framework: The Booklet System

A search of various research and academic databases and the internet in general revealed nothing written about the Booklet System in educational research. As a result this topic is unique. So attention has to be turned to the conceptual framework upon which the Booklet System is based. What are the theories and principles underlying the Booklet way of learning?

Appendix 1 gives an overview of the Booklet System. When this System was devised, a well thought through system of goals was developed (see Appendix 3) and then the Booklet System was built to achieve these goals. In summary they are:-

1. To develop students' self-determination by encouraging them to set achievable goals. Students take responsibility for their own learning. The teacher is merely a support and facilitator of the student's learning activities.
2. For the less mathematically able students the goal is to thoroughly prepare them for the syllabus required by the Queensland Senior Mathematics A course. The overriding goal for the Year 9 and 10 (Ordinary) Mathematics student is to "maintain the motivation".

3. For the brighter students the goal is to thoroughly prepare them for the rigors of Queensland Mathematics B and C in senior Mathematics. The overriding goal for the Year 9 and 10 Extension Mathematics student is to develop the "attitude of excellence". It is proposed that achieving excellence is really nothing more than building a habit; the habit of being all you can be within whatever context.
4. To "fit' mathematics into a busy life by giving students time management skills.
5. To build their self-confidence through success at small achievable goals. Each Booklet is a small chunk and students feel they can cope with this, thus motivating them.

It is apparent then that the principles underlying the Booklet System are:- self-learning, self-determination, self-confidence, reading and developing time management skills. Searches revealed a wealth of studies and papers. Relevant studies were grouped under the following headings: individualised instruction, self-instructional learning, improving skills / test design, attitudes and reading. Each of these areas was then researched.

2.2.1 Individualised Instruction

An experimental program in mathematics at a high school in Watts, California, demonstrated that multilevel team teaching and individualized instruction produced significantly higher student achievement in computational skills than did traditional methods (Baley & Benesch, 1969). The only teaching done by the teachers or teaching assistants was done individually in response to a student question. On a standardized mathematics test, the student group that experienced individualized instruction was found to improve on average about two-fifths of a semester in grade level more than the control group students with the same starting scores. They could achieve more in a shorter period of time.

A similar study was done at three schools over three years. The three schools were identified as a model of individualized instruction, a school with a similar population of youngsters using more conventional instruction, and a school whose children have higher socioeconomic status (SES) and intelligence. (Anttonen & Broome, 1977). The testing showed that the school that emphasized individualized instruction showed a greater gain from third to fifth grade in reference skills and independent study skills. The findings also support the view that children in an individualized program had better attitudes towards school and school subjects.

A third study at a community college (Gudan, 1995) compared the effectiveness of individualized and traditional sections in a basic mathematics class. The study indicated that the individualized format was a positive experience for students and enhanced skill development for participating students, but only minimally decreased math anxiety and had no effect on grades.

2.2.2 Self-Instructional Learning

Although not recent, a study by Thatcher was conducted to determine the relative efficacy of programmed self-instructional materials compared to the traditional methodology and text material (Thatcher 1962) in teaching mathematics. His results indicate that

> ... programmed teaching presents information to the student equally as well as the traditional classroom methods, allows students to progress at their own ability rate, and provides students an opportunity to meet the particular course objectives with considerable time saving. (p. 65)

At the same time Brown (1962) conducted a similar study on eleven mathematics classes at seven high schools and came to a similar conclusion.

Wong, Lawson and Keeves (1998) used South Australian Grade 9 Mathematics students to compare the performance of students using self-explanation procedures to that of students

using typical study procedures. The processing activities used by students were also observed. They discovered that the self-explanation group showed more frequent use of each type of processing activity and also obtained higher scores on the problem-solving test.

These studies and a number of papers collated by Long (1996 and 1997) all attest that students could learn specific subject matter and acquire certain skills as effectively by the use of well-constructed self-directed learning programs as by the use of traditional teacher-taught methods.

2.2.3 Improving Skills / Test Design

A common approach to evaluate student skills has been the Pre Test / Post Test approach (Skager 1969, Allen & Ross 1974, Rasberry and Turner 1988, Lightner 1998). Eligible students were tested at the beginning and end of the school year with two forms of specially constructed mathematics tests. Their performance was assessed to compare their acquisition of mathematical skills. This approach will be used when it comes to examining the Booklet System.

2.2.4 Attitude

Rasberry and Turner's (1988) study mentioned above presented interesting findings regarding achievement and attitudes consistent with most past research. They compared sixth-grade students enrolled in an alternative school with students in a traditional school on the bases of academic achievement and attitudes toward school subjects.

No significant differences existed between alternative and traditional students' performance in achievement except that males performed better in science. Findings on attitudes toward school subjects were consistent with prior research indicating that gender is a better predictor of attitude than participation in alternative school programs.

2.2.5 Reading

A self-instructional Booklet System obviously relies on the ability to read and understand mathematical explanations. Ediger (1997) notes that pupils "need to experience a variety of reading activities in mathematics" (p. 1). As well, "these should be on the understanding levels of individual learners" (Ediger, p. 23).

Pupils do differ from each other in the quality of reading exhibited in mathematics. Abraham (1983) seems to agree with Ediger when Ediger advocates a "one teacher and one pupil approach . . . for those learners who have problems in word recognition and comprehension of content or subject matter" (Ediger, p. 9). Krulik (1980) also notes the high correlation between problem solving in mathematics and comprehension in reading.
Thus it seems that the individual attention students receive doing the Booklet System as well as the claimed suitable reading level are advantageous to the comprehension of mathematical content.

2.3 Summary of Literature Review

The most significant contribution of existing research is that it strongly tells us that individualised learning is effective at least as well as conventional teacher-directed learning. However, existing research does not tell us that individualised learning in the mathematics arena leads to a greater retention of mathematical knowledge and ability. The study of the Booklet System should add to this area in current research.

Many studies have been done using the Pre Test / Post Test method. This has been useful and thus will also be the method used to study the effectiveness of the Booklet System.

Also, the studies by Ediger and Krulik make it clear that if the Booklet System is going to be effective then the problem of suitable reading levels needs to be addressed.

Finally, Rasberry and Turner's (1988) work suggest that attitude towards mathematics is not an issue to be considered as no significant differences existed in students' achievement between alternative and traditional schools. However, a survey on attitudes will be administered to further investigate how this may relate to the different methods of teaching mathematics.

For a new mathematics system to be devised, some deficiencies must be seen to be present in the existing mathematics system. The literature review undertaken indicates that a mathematics system based on individualised learning has merit. It will be interesting to determine if the Booklet System will prove to be effective academically.

2.4 Rationale for this Study

Even though there have been a number of studies examining the influence of the learning environment on student achievement, no studies have been found in the literature that investigate the impact of the Booklet System approach to Mathematics teaching. Despite this, it will be interesting to see how students manage and perceive the operation of an alternative mathematical program and in placing this in the context of previous learning environment studies already mentioned. This study is thus an important one.

3 Methodology

3.1 Study Design

The research methodology chosen to study the effectiveness of the mathematics Booklet System is that of *action research*.

3.1.1 Why Action Research?

Kemmis and McTaggart define action research as: -

> ... a form of collective, self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out. (1988, p. 5).

The emphasis is on improvement by solving problems and developing new skills or approaches (Isaac and Michael, 1995, p. 55). Put simply, action research is `learning by doing' – an individual or a group of people identifies a problem, does something to resolve it, sees how successful their efforts were, and, if not satisfied, tries again. It is an iterative process that converges towards a better understanding of what happens (Dick, 1999).

Action research is different from common problem-solving activities that we all engage in every day in that the emphasis is on scientific study. "The researcher studies the problem systematically and ensures the intervention is informed by theoretical considerations" (O'Brien, 1998). Also, Mettetal (2000) outlines a number of differences between action research and formal research.

3.1.2 Steps in the Action Research Process

Kemmis et.al. (1988) and Susman (1983) have both developed simple models of the cyclical nature of the typical action research process.

Essentially these different approaches contain the following steps: -

1. Identify the problem

The initial problem refers to "a state of affairs or situation a participant wishes to change or improve on" (Burns, 2000, p. 445).

In the context of this research study the problem is the mathematical effectiveness of the Booklet System.

2. Plan

This involves a literature review (see Section 2.2 and 2.3) to learn from other similar studies as well as some form of research and data collection strategy learning from the action and reflection from previous cycles.

3. Data Collection (Act and Observe)

Methods can be qualitative or quantitative, descriptive or experimental (Mettetal, 2000). As data is collected methods are refined as needed.

As mentioned earlier, many studies have been done using the Pre Test / Post Test method. This has been useful and thus will also be the method used to study the effectiveness of the Booklet System.

Appropriate tests will be procured that adequately cover the Queensland Year 8 and then the Year 9 syllabi.

A pilot study will be conducted at the end of 2003 on a group of Year 9 students to check the Pre Test and Post Test testing instruments.

These will be refined before being issued to four Year 9 classes at the beginning of 2004. Two of these classes will be ones that use the Booklet System and will come from Northpine Christian College in Brisbane. The other two classes will come from two

Brisbane schools of similar demographic to the one that uses the Booklet System yet they will not use this System.

At the end of 2004 these four classes will again be tested using the Post Test.

4. Data Analysis

The data could either be qualitative or quantitative.

In the Booklet System under study the data will be quantitative. Thus the results from these tests will be statistically analysed with the SPSS statistical package to determine if there is any correlation between academic attainment and studying the Booklet System.

5. Reflect and Take Action

Sense is made of the data. Burns (2000, p. 448) suggests writing a case study at the end of each cycle to evaluate the overall project. The findings are interpreted in light of how successful the action has been. Postulation is made of other possible strategies to use and the problem is re-assessed.

At the end of this study of the Booklet System relevant conclusions will be drawn regarding its mathematical effectiveness and then recommendations will be made for future examination.

6. Repeat the Cycle

The new interventional strategies are carried out. The cyclic process repeats, constantly being monitored over varying periods of time by a variety of mechanisms. This continues until a sufficient understanding of, or implementable solution for, the problem is achieved.

If necessary, further testing of the effectiveness of the Booklet System may be done to clarify or refine the conclusions drawn. This cannot be determined until the Pre Tests and Post Tests can be analysed. Repeating this cycle was left for a further study.

3.1.3 Strengths of Action Research

The following are noted as strengths of the action research process:-

i) It can be used readily in work or community situations.

Mainstream research paradigms in some field situations can be more difficult to use.

ii) It increases learning and improves the research situation.

The educator Schön (1987, p. 28) argues strongly that systematic reflection is an effective way for practitioners to learn.

iii) It is usually participative and collaborative.

Clients are involved in the research process usually working together with the researchers to improve their own practices (Kemmis and McTaggart, 1988, p. 22, 23). People learn best, and more willingly apply what they have learned, when they are involved in the learning process.

iv) It is an integrated approach.

There need be no gap between theory, research and practice. The three can be integrated.

v) It is a responsive approach.

"To achieve action, action research is responsive" (Dick, 2000) where constant monitoring and reassessment occurs.

vi) It is a wholistic approach.

Embedded in the Booklet System is the aim to promote an all-rounded approach to education (see Appendices 2 and 3). The strengths of action research already listed indicate that consideration would be given to all pertinent aspects of the everyday operation of the Booklet System.

vii) It makes economical use of data.

Most qualitative research accumulates such large bodies of data that researchers cannot fully deal with. Action research offers an economy in that only the interpretations need be carried from cycle to cycle.

3.1.4 Ethical Considerations

Because action research is carried out in real-world circumstances, and involves close and open communication among the people involved, the researchers must pay close attention to ethical considerations in the conduct of their work. Winter (1996) and Kemmis and McTaggart (p.106-108) list a number of these principles such as:- full consultation with all relevant persons, committees and authorities; open and visible development of all work; accepting responsibility for maintaining confidentiality.

For these reasons, to ensure this study meets all the relevant legal and ethical requirements, an ethics submission will be made following all aspects of Avondale College's Human Research Ethics Policy.

3.2 Procedure

3.2.1 Sample

Since the Booklet System has limited usage the database of students was limited. To enable a similar demographic of students for those using the Booklet System and those not using it, the study was limited to three private, Christian schools of similar ethos and makeup. A fourth private, Christian school using the Booklet System originally agreed to participate in the study but withdrew shortly before the Pre Test was administered. Also, it would be advantageous to have equal numbers in each of the opposing study groups. Thus, two Year 9 classes operating with the Booklet System were selected from a Christian

College on the north side of Brisbane (to be called School 1) and two Year 9 classes not operating with the Booklet System were selected from two other schools (to be called School 2 and School 3), one Year 9 class from each of the schools. Both of these schools used the same textbook.

3.2.2 Measurement Instruments

3.2.2.1 Student Attitudes

To determine student attitudes a suitable questionnaire needed to be found. It was decided to use one that was administered by the West Australian Department of Education Research Branch in 1972; "Attitude-To-Subject Questionnaire". An email was sent asking for permission to use this questionnaire but their reply stated that present records indicated no knowledge of its source. The questionnaire was subsequently used (see Appendix 5).

This questionnaire consisted of 40 questions, each measured by a four-point likert-scale from Strongly Agree to Strongly Disagree. The Attitude-To-Subject Questionnaire assessed an eight-factor model describing the various components of student attitude to the mathematics learning environment;

Interest in the Subject (Q 1,9,17,25,33),

Perceived Value of the Subject (Q 2,10,18,26,34),

Attitude To Subject Teacher Q 3,11,19,27,35),

Class Management (Q 4,12,20,28,36),

Perception of Own Ability (Q 5,13,21,29,37),

Attitude To Other Students (Q 6,14,22,30,38),

Perceived Teacher Attitude To Students (Q 7,15,23,31,39),

Attitude To Homework (Q 8,16,24,32,40).

This student attitude instrument was felt to be appropriate because it assessed a number of aspects of student attitude that have been the subject of previous studies of teacher-student

relationships (Rickards et al, 2003) and academic efficacy (Dorman et al, 2004). As well, it assessed a number of factors that were felt important to the classroom teacher in determining the classroom learning environment such as attitude to the subject and homework.

3.2.2.2 Student Achievement

One of the aims of this study was to determine what level of learning happened in each of the classrooms under the two different systems. It was important not to make the Pre Test and Post Test the same as the amount of learning that occurred throughout the year needed to be measured, not just each student's conceptual understanding of basic mathematical concepts. It was necessary to find a test instrument that reflected the knowledge base occurring in a typical Year 9 Queensland syllabus and covering the content of the Booklets and textbook used.

Various test instruments were examined both from Australia and overseas and compared to a Queensland Year 9 syllabus, including the coverage of the Booklets and text. The instruments that best fit these criteria were two in a series of eight standardized tests prepared by the National Foundation for Educational Research (NFER) in the United Kingdom. NFER is the UK's leading independent research organisation carrying out research in the field of education. These tests are supplied by Professional Resources Services in Victoria and adapted by them for use in Australia. The Mathematics 13 test is intended for students who are thirteen years old while the Mathematics 14 test is intended for students who are fourteen years old.

The language used in the questions of each test has been kept as simple as possible while maintaining appropriate mathematical terminology with which pupils of these ages should be familiar.

There are two sections in each test. The first section requires a calculator and takes approximately 30 minutes. Calculators are then handed to the teacher before the second non-calculator section is completed in approximately 35 minutes.

Each test covers Number, Algebra, Measurement, Shape and Space, Handling Data and Probability. Each question addresses one of five process categories:

- Computation and Knowledge – the ability to perform straightforward computations or well-rehearsed techniques
- Application of Skills – applying operations or skills to various contexts
- Application of Concepts – application of important mathematical concepts (eg ratio, mean, probability)
- Interpretation and Evaluation – interpreting and evaluation information from graphs and diagrams
- Application of Patterns and Relationships – applying operations that are not immediately obvious

Since these are standardized tests the questions cover a range of difficulty in order to differentiate between students who are operating at different levels of understanding and attainment.

Professional Resources Services in Victoria offer a service of marking the tests and providing the standardized scores.

3.2.2.3 Student Ability

All students were given the same Pre Test and Post Test. In order to see what effect ability level has on attitude and performance across schools and teaching approaches, the marks from the Pre Test were used to split the students into three ability groups as follows:-

Low ability group - students with a raw score from 0 to 23

Intermediate ability group - students with a raw score from 24 to 31

High ability group - students with a raw score of 32+

Three databases were emulated from the main database representing each of these ability groups.

Student performances in each group were analysed for changes in attitude and achievement as the year progressed.

3.2.3 Testing Schedule

Six months were allowed to procure a suitable Attitude Questionnaire, a Pre Test and a Post Test and to test their validity. The Attitude Questionnaire and the Pre Tests (Math 13 tests) were then administered in the second week of the 2004 Queensland school year to each of the four Year 9 classes at the three schools under exam conditions. The data from the Attitude Questionnaires was entered into a spreadsheet and analysed using SPSS, a statistical package. The Math 13 tests were sent to Professional Resource Services for marking and preparation of a summary report containing scores and means. The data from this report was re-entered into a spreadsheet for analysis.

This entire process was repeated at the end of the 2004 school year. The Attitude Questionnaires and Post Tests (Math 14 tests) were administered in the second last week of the 2004 Queensland school year to each of the four Year 9 classes at the three schools under exam conditions. The data was examined in the same way as at the beginning of the year.

Following this the complete sets of data were statistically examined and conclusions drawn.

4 Attitude To Mathematics

4.1 Attitude Scale

Using the Cronbach Alpha coefficient the internal consistencies reliability for the eight-factor attitude model ranged from 0.887 to 0.580 (see Table 4.1) showing that this instrument is valid and reliable when used in this context.

Table 4.1 Eight-Factor Attitude Scale internal Consistency

Factor	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Class Management	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Cronbach Alpha	0.887	0.797	0.764	0.580	0.782	0.670	0.873	0.676

4.2 Pre Test Attitude Results

4.2.1 Attitude: Profile Pre Test

The respective factors within the attitude scale (Table 4.2 on the next page) all registered mean values above "2" (2.14 to 2.75). Since values of 3 and 4 represent positive responses, this indicates that the majority of students displayed a positive view to all factors.

The factors with highest positive ratings overall were 'perception of own ability' and 'attitude to other students' and the factors with lowest ratings were 'attitude to subject teacher' and 'perceived class management'.

4.2.2 Attitude: School Comparison Pre Test

Also shown in Table 4.2 are the relative rankings of the respective attitude factors Pre Test. The bottom ranked factor is the same for all schools. However, School 1 has a different top ranked factor and was appreciably different to the other two schools in other rankings too.

What also is different is the magnitude of the ratings. School 1 had significantly lower ratings than the other two schools ($p = 0.002$ and $p = 0.08$) for 'perception of own ability' and significantly higher ratings than the other two schools ($p = 0.003$ and $p = 0.000$) for 'attitude to other students'. School 2 had significantly higher ratings than the other two schools ($p = 0.000$ and $p = 0.002$) for 'perceived class management'. In terms of 'perceived teacher attitude to students' all schools were significantly different ($p < 0.05$) to each other with School 1 having the lowest rating and School 3 having the highest rating.

Table 4.2 Attitude Profile; Overall and School Groups Pre Test

Group	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Perceived Class Manage-ment	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Overall Mean	2.44	2.61	2.14	2.31	2.66	2.75	2.44	2.32
Overall SD	0.307	0.258	0.323	0.336	0.275	0.362	0.352	0.280
Overall Ranking	4	3	8	7	2	1	5	6
School 1 Mean	2.38	2.64	2.20	2.22	2.54	2.93	2.31	2.38
School 1 SD	0.336	0.243	0.349	0.264	0.270	0.350	0.370	0.287
School 1 Ranking	4	2	8	7	3	1	6	5
School 2 Mean	2.518	2.576	2.118	2.612	2.812	2.612	2.435	2.294
School 2 SD	0.309	0.291	0.283	0.350	0.278	0.278	0.276	0.284
School 2 Ranking	5	4	8	2	1	3	6	7
School 3 Mean	2.50	2.56	2.07	2.25	2.76	2.49	2.70	2.21
School 3 SD	0.220	0.264	0.292	0.323	0.166	0.219	0.210	0.238
School 3 Ranking	4	3	8	6	1	5	2	7

4.2.3 Attitude: Gender Comparison Pre Test

T-tests for the eight attitude factors did not find any significant differences overall in the male ratings when compared to the female ratings Pre Test. It was noted, however, that the recorded mean male student ranking was higher than the mean female ratings for all the attitude factors except 'perception of own ability' and 'attitude to other students', which even

then were very similar to the females. This seems to go against previous research that suggests that females perceive their teachers in a more positive way than do males. At the school level, for School 2 the male students showed a significantly higher ($p = 0.029$) positive attitude than the females in the 'attitude to homework' factor and for School 3 the female students showed a significantly higher ($p = 0.048$) positive attitude than the males in the 'perception of own ability' factor.

4.2.4 Attitude: Ability Comparison Pre Test

The one-way ANOVA test (refer Table 4.3) was run on the Pre Test attitude scores of the ability sub-groups:- low ability (N = 28), intermediate ability (N = 25), high ability (N = 26).

Table 4.3 Attitude Profile; Ability Groups Pre Test

Group	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Class Manage-ment	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Overall Mean	2.441	2.605	2.147	2.311	2.656	2.749	2.438	2.316
Overall SD	0.308	0.258	0.323	0.336	0.275	0.362	0.352	0.280
Overall Ranking	4	3	8	7	2	1	5	6
High Mean	2.536	2.529	2.043	2.314	2.671	2.736	2.429	2.300
High SD	0.322	0.232	0.285	0.342	0.284	0.365	0.265	0.320
High Ranking	3	4	8	6	2	1	5	7
Intermed Mean	2.424	2.632	2.208	2.288	2.632	2.712	2.568	2.320
Intermed SD	0.211	0.243	0.308	0.232	0.221	0.317	0.293	0.216
Intermed Ranking	5	3	8	7	2	1	4	6
Low Mean	2.354	2.662	2.200	2.331	2.662	2.800	2.323	2.331
Low SD	0.350	0.287	0.358	0.242	0.319	0.404	0.448	0.299
Low Ranking	4	3	8	6	2	1	7	5

The results showed that no significant difference existed between the different ability levels in any of the attitude factors. It is interesting to note, however, that there is a noticeable and expected trend in the 'interest in the subject' factor with mean interest ratings of 2.354,

2.424, 2.536 for the low, intermediate and high ability levels respectively. Further, there was an unexpected distribution of similar mean ratings for the various ability levels in the 'perception of own ability' factor of 2.662, 2.632 and 2.671. It appears that these students are relatively unaware of their own ability.

Similar tests also showed no significant gender differences between ability groups.

4.3 Post Test Attitude Results

4.3.1 Attitude: Profile Post Test

The respective factors within the attitude scale Post Test (Table 4.4 below) all registered mean values above "2" (2.15 to 2.74) indicating that the majority of students continued to display a positive view to all factors.

Table 4.4 Attitude Profile; Overall and School Groups Post Test

Group	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Class Manage-ment	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Overall Mean	2.44	2.57	2.15	2.29	2.61	2.74	2.43	2.27
Overall SD	0.244	0.279	0.326	0.289	0.257	0.358	0.271	0.273
Overall Ranking	4	3	8	6	2	1	5	7
School 1 Mean	2.41	2.53	2.20	2.25	2.58	2.87	2.33	2.26
School 1 SD	0.236	0.253	0.349	0.303	0.300	0.312	0.241	0.287
School 1 Ranking	4	3	8	7	2	1	5	6
School 2 Mean	2.42	2.71	2.118	2.41	2.68	2.65	2.54	2.28
School 2 SD	0.244	0.368	0.283	0.240	0.235	0.397	0.243	0.301
School 2 Ranking	5	1	8	6	2	3	4	7
School 3 Mean	2.52	2.53	2.07	2.25	2.61	2.56	2.53	2.27
School 3 SD	0.255	0.218	0.292	0.282	0.152	0.322	0.285	0.227
School 3 Ranking	5	3	8	7	1	2	3	6

The factors with highest positive ratings overall were 'attitude to other students' and 'perception of own ability' and the factors with lowest ratings were 'attitude to subject teacher' and 'attitude to homework'.

4.3.2 Attitude: School Comparison Post Test

As shown in Table 4.4 above the relative rankings of the respective attitude factors is just about the same between schools for the top and bottom ranked factors.

There are only two significant differences between schools Post Test. School 1 had significantly lower ratings than the other two schools ($p = 0.017$ and $p = 0.017$) for 'perceived teacher attitude to students'. School 1 also had significantly ($p = 0.004$) higher ratings than School 3 for 'attitude to other students'.

4.3.3 Attitude: Gender Comparison Post Test

T-tests for the eight attitude factors did not show any significant differences overall in the male ratings when compared to the female ratings Post Test. It was noted that the recorded mean male student ranking was higher than the mean female ratings for all the attitude factors except 'attitude to the teacher' and 'attitude to other students', which even then were very similar to the females.

At the school level, however, for School 3 the male students showed a significantly higher ($p = 0.029$) positive attitude than the females in the 'interest in subject" factor ($p = 0.010$), the 'perceived teacher attitude to students' factor ($p = 0.001$). Interestingly, for that same school the female students showed a significantly higher ($p = 0.034$) positive attitude than the males in the 'attitude to teacher' factor.

4.3.4 Attitude: Ability Comparison Post Test

The one-way ANOVA test (refer Table 4.5) was run on the Post Test attitude scores of the ability sub-groups (low ability, intermediate ability, high ability).

Table 4.5 Attitude Profile; Ability Groups Post Test

Group	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Class Manage-ment	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Overall Mean	2.438	2.570	2.149	2.286	2.608	2.744	2.425	2.266
Overall SD	0.244	0.279	0.326	0.289	0.257	0.358	0.271	0.273
Overall Ranking	4	3	8	6	2	1	5	7
High Mean	2.543	2.586	2.034	2.229	2.664	2.793	2.471	2.307
High SD	0.243	0.217	0.256	0.287	0.313	0.423	0.284	0.285
High Ranking	4	3	8	7	2	1	5	6
Intermed Mean	2.464	2.584	2.152	2.256	2.584	2.720	2.408	2.192
Intermed SD	0.214	0.215	0.302	0.249	0.172	0.258	0.196	0.234
Intermed Ranking	4	3	8	6	2	1	5	7
Low Mean	2.300	2.538	2.269	2.377	2.569	2.715	2.392	2.292
Low SD	0.214	0.383	0.379	0.317	0.257	0.372	0.317	0.290
Low Ranking	6	3	8	5	2	1	4	7

The results showed that no significant difference existed between the different ability levels in all the attitude factors, except the 'interest in the subject' factor'. In this factor, the mean ratings were 2.300, 2.464, 2.543 for the low, intermediate and high ability levels respectively, and these differences were significant at the 0.05 level. As with Pre Test results, there was an unexpected distribution of mean ratings for the various ability levels in the 'perception of own ability' factor of 2.569, 2.584 and 2.664. One again, it appears that these students are still unaware of their own ability.

4.4 Comparisons Between Attitudes Pre Test and Post Test

4.4.1 Attitude Differences

In order to compare attitudes before the school year began and at the end of the school year for each of the schools, columns were added to the data table for differences between Pre and Post totals for each of the eight attitude factors. The difference was found by subtracting the Pre total from the Post total. A positive difference represents an increase in positive attitude throughout the school year. An analysis of these differences gives rise to the following observations.

4.4.2 Attitude: Profile Comparisons Pre and Post

Table 4.6 (next page) shows the means and standard deviations of the differences for each attitude factor before the school year began and at the end of the school year overall and for each of the schools.

Overall, across all schools, all factors except 'attitude to teacher' decreased in positive attitude, yet all the decreases were only minimal. The factors which had the greatest decrease in positive attitude overall were 'perception of own ability' and 'attitude to homework' and the factors which had the lowest decrease were 'attitude to other students' and 'interest in the subject'.

4.4.3 Attitude: School Comparisons Pre and Post

Table 4.6 on the next page shows many varying changes in attitudes at each school. Paired samples t-tests revealed the following attitude changes.

Table 4.6 Difference in Post-Pre Attitude Ratings; Overall and School Groups

Group	Interest in the Subject	Perceived Value of the Subject	Attitude To Subject Teacher	Perceived Class Manage-ment	Perception of Own Ability	Attitude To Other Students	Perceived Teacher Attitude To Students	Attitude To Homework
Overall Mean	-0.0025	-0.0354	0.0025	-0.0253	-0.0481	-0.0051	-0.0127	-0.0506
Overall SD	0.3194	0.3084	0.3903	0.3543	0.3541	0.3637	0.3740	0.3672
Overall Ranking	2	6	1	5	7	3	4	8
School 1 Mean	0.0238	-0.1048	-0.0524	0.0333	0.0333	-0.0571	0.0143	-0.1190
School 1 SD	0.3512	0.3036	0.3903	0.3333	0.3613	0.3908	0.3886	0.3952
School 1 Ranking	3	7	5	2	1	6	4	8
School 2 Mean	-0.0941	0.1294	0.1412	-0.2000	-0.1294	0.0353	0.1059	-0.0118
School 2 SD	0.3249	0.3077	0.3922	0.3391	0.4180	0.3622	0.2749	0.3039
School 2 Ranking	6	2	1	8	7	4	3	5
School 3 Mean	0.0200	-0.0300	0.0000	0.0000	-0.1500	0.0700	-0.1700	0.0600
School 3 SD	0.2331	0.2774	0.3784	0.3784	0.2328	0.2993	0.3799	0.0755
School 3 Ranking	3	6	5	4	7	1	8	2
Non Booklet Schools Mean	-0.0324	0.0432	0.0649	-0.0919	-0.1405	0.0541	-0.0432	0.0270
Non Booklet Schools SD	0.2809	0.2987	0.3860	0.3700	0.3261	0.3254	0.3594	0.3203
Non Booklet Schools Ranking	5	3	1	7	8	2	6	4

4.4.3.1 School 1 Attitude Comparisons Pre and Post

For School 1 the greatest average decreases in attitudes occurred for the 'perceived value of the subject' and 'attitude to homework' factors. However, a significant decrease ($p = 0.048$) in positive attitude occurred in the 'attitude to other students' factor and a significant increase ($p = 0.041$) in positive attitude occurred in the 'perceived class management' factor.

4.4.3.2 School 2 Attitude Comparisons Pre and Post

While School 2 seemed to have the greatest variation in changes, there was only one change that was significant. There was a significant increase ($p = 0.014$) in positive attitude in the 'perceived value of the subject' factor.

4.4.3.3 School 3 Attitude Comparisons Pre and Post

For School 3 the greatest average decreases in attitudes occurred for the 'perception of own ability' and 'perceived teacher attitude to students' factors. However, there was only one change that was significant. There was a significant increase ($p = 0.017$) in positive attitude in the 'interest in the subject' factor.

4.4.4 Attitude: Comparisons Pre and Post – Booklet / NonBooklet

The difference between Post Test scores and Pre Test scores (Post minus Pre) for each attitude factor were calculated and T-tests were used to compare the Booklet Use group (N=42) with the NonBooklet Use group (N=37). Table 4.7 shows the means and standard deviations of these differences.

Table 4.7 Difference in Post-Pre Attitude Ratings; Booklet / NonBooklet

		Mean	SD	t	p
Difference in interest in the Subject	Booklet Use	0.0238	0.3512	-0.779	0.438
	Booklet Non-use	-0.0324	0.2809		
Difference in Perceived value of the subject	Booklet Use	-0.1048	0.3036	2.179	**0.032**
	Booklet Non-use	0.0432	0.2987		
Difference in Attitude to the Subject Teacher	Booklet Use	-0.0524	0.3903	1.339	0.184
	Booklet Non-use	0.0649	0.3860		
Difference in Perceived Class Management	Booklet Use	0.0333	0.3333	-1.583	0.118
	Booklet Non-use	-0.0919	0.3700		
Difference in Perception of Own Ability	Booklet Use	0.0333	0.3613	-2.233	**0.028**
	Booklet Non-use	-0.1405	0.3261		
Difference in Attitude to Other Students	Booklet Use	-0.0571	0.3908	1.363	0.177
	Booklet Non-use	0.0541	0.3254		
Difference in Perceived Teacher Attitude to Students	Booklet Use	0.0143	0.3886	-0.680	0.499
	Booklet Non-use	-0.0432	0.3594		
Difference in Attitude to Homework	Booklet Use	-0.1190	0.3952	1.789	0.078
	Booklet Non-use	0.0270	0.3203		

Between the school that used Booklets and the two schools that didn't use Booklets there are definite differences in rankings (refer Table 4.6). As noted in Table 4.7, the greatest decrease in positive attitude for the NonBooklet schools is in the 'perception of own ability' factor. This same factor for the Booklet school (School 1) had the greatest increase in positive attitude but wasn't significant.

The factor 'perceived class management' has a similar analogy but wasn't significant. It is the equally highest rise for the Booklet school (School 1) while it is the second lowest decrease for the NonBooklet schools. The 'attitude to homework' factor has the highest decrease in positive attitude for the Booklet school (School 1) while for the NonBooklet schools it has a middle ranking with a very slight increase in positive attitude.

The first significant statistical difference ($p = 0.028$) is that students from the Booklet schools significantly improved their 'perception of own ability' factor over those students from the NonBooklet schools. The second significant statistical difference ($p = 0.032$) is that students from the NonBooklet schools significantly improved their 'perceived value of the subject' over those students from the Booklet school.

4.4.5 Attitude: Comparisons Pre and Post – Gender

Table 4.8 (next page) shows the means and standard deviations of the differences for each attitude factor for all the males ($N = 42$) and the females ($N = 37$).

Table 4.8 Difference in Post-Pre Attitude Ratings; Male / Female Overall

		Mean	SD	t	p
Difference in interest in the Subject	Male	-0.0048	0.3231	0.066	0.948
	Female	-0.0000	0.3197		
Difference in Perceived value of the subject	Male	0.0333	0.2993	-2.161	**0.034**
	Female	-0.1135	0.3038		
Difference in Attitude to the Subject Teacher	Male	-0.0333	0.3924	0.869	0.388
	Female	0.0432	0.3891		
Difference in Perceived Class Management	Male	-0.0667	0.3412	1.107	0.272
	Female	0.0216	0.3675		
Difference in Perception of Own Ability	Male	-0.0190	0.3118	-0.775	0.441
	Female	-0.0811	0.3985		
Difference in Attitude to Other Students	Male	-0.0000	0.3722	-0.131	0.896
	Female	-0.0108	0.3588		
Difference in Perceived Teacher Attitude to Students	Male	-0.0333	0.3244	0.521	0.604
	Female	-0.0108	0.4267		
Difference in Attitude to Homework	Male	-0.0524	0.4098	0.045	0.964
	Female	-0.0486	0.3177		

There is only one significant difference between the males and females across all schools. Table 4.8 indicates that the males had a significant increase ($p = 0.034$) in attitude over the females throughout the year when it comes to 'perceived value of the subject'.

Similar independent samples t tests to Table 4.8 were conducted to compare males and females at each individual school throughout the year. The only school to show any significant difference in attitude between the males and females was School 2. Here the males had a significant ($p = 0.023$) improvement in attitude as compared to the females when it came to 'perceived teacher attitude to students'.

As well, performances for each gender were considered throughout the year for the Booklet school and the NonBooklet schools. No significant gender differences in attitude were found in either group.

4.4.6 Attitude: Comparisons Pre and Post – Ability Levels

An ANOVA on each of the three ability groups was done. Table 4.9 shows the means and standard deviations of the Pre and Post differences for each attitude factor for the three

ability levels:- low ability (Booklet N = 15, NonBooklet N = 11), intermediate ability (Booklet N = 13, NonBooklet N = 12) and high ability (Booklet N = 14, NonBooklet N = 14).

Table 4.9 Difference in Post-Pre Attitude Ratings; Ability Groups

		Low Ability				Intermediate Ability				High Ability			
		Mean	**SD**	**t**	**p**	**Mean**	**SD**	**t**	**p**	**Mean**	**SD**	**t**	**p**
Difference in Totals	Booklet Use	-0.0283	0.1742	-0.080	0.937	-0.0596	0.1121	-0.328	0.746	0.0000	0.4297	-0.344	0.734
	Booklet Non-use	-0.0227	0.1801			-0.0458	0.0964			0.0179	0.1350		
Difference in interest in the Subject	Booklet Use	0.0000	0.3928	0.886	0.384	0.0769	0.1922	1.004	0.326	0.0000	0.4297	-0.100	0.921
	Booklet Non-use	-0.1273	0.3133			0.0000	0.1907			0.0143	0.3183		
Difference in Perceived value of the subject	Booklet Use	-0.2667	0.3177	-2.404	**0.024**	-0.0462	0.2602	0.033	0.974	0.0143	0.2656	-1.048	0.304
	Booklet Non-use	0.0727	0.4027			-0.0500	0.3205			0.1000	0.1519		
Difference in Attitude to the Subject Teacher	Booklet Use	-0.0400	0.4911	-1.38	0.18	-0.1231	0.3789	-0.903	0.376	0.0000	0.2828	0.126	0.901
	Booklet Non-use	0.2182	0.4423			0.0167	0.3951			-0.0143	0.3183		
Difference in Perceived Class Management	Booklet Use	0.1733	0.3535	1.952	**0.043**	0.0308	0.3250	1.022	0.317	-0.1143	0.2685	-0.453	0.645
	Booklet Non-use	-0.1273	0.4315			-0.1000	0.3133			-0.0571	0.3877		
Difference in Perception of Own Ability	Booklet Use	0.0133	0.4033	1.493	0.149	0.0462	0.1854	3.079	**0.005**	0.0429	0.4519	0.664	0.513
	Booklet Non-use	-0.2364	0.4456			-0.1500	0.1243			-0.0571	0.3368		
Difference in Attitude to Other Students	Booklet Use	-0.1867	0.3335	-1.741	0.095	-0.0615	0.3776	-1.071	0.295	0.0857	0.4348	0.387	0.702
	Booklet Non-use	0.0545	0.3698			0.0833	0.2887			0.0286	0.3407		
Difference in Perceived Teacher Attitude to Students	Booklet Use	0.1333	0.4254	0.839	0.410	-0.1385	0.3595	0.342	0.73	0.0286	0.3496	-0.244	0.809
	Booklet Non-use	-0.0182	0.4936			-0.1833	0.2887			0.0571	0.2652		
Difference in Attitude to Homework	Booklet Use	-0.0533	0.3962	-0.246	0.808	-0.2615	0.2873	2.122	0.055	-0.0571	0.4669	-0.858	0.399
	Booklet Non-use	-0.0182	0.3027			0.0167	0.3664			0.0714	0.3099		

As can be seen from Table 4.9, when it comes to attitude changes, there are no significant differences for high ability students between those that use Booklets and those that don't.

For intermediate ability students, those that do not use Booklets have a significant improvement ($p < 005$) in the perception of their own ability compared with those that don't use Booklets.

For low ability students, two opposing effects have occurred. The NonBooklet students have significantly improved ($p = 0.024$) their perceived value of mathematics when compared to the Booklet students while significantly lowering ($p = 0.043$) their perception of classroom management when compared to the Booklet students.

5 Student Achievement

5.1 Achievement Scale

The NFER standardized Mathematics 13 test was used to determine student achievement across a set of five process categories: Computation and Knowledge, Application of Skills, Application of Concepts, Interpretation and Evaluation, Application of Patterns and Relationships. The final results for each of these categories for each student were determined by combining the relative calculator and non-calculator questions for each respective category.

5.2 Pre Test Achievement Results

5.2.1 Achievement: Profile Pre Test

The achievement profile of means and standard deviations for the Pre Test is displayed in Table 5.1 below. All means are percentages.

Table 5.1 Achievement Profile; Overall and School Groups Pre Test %

Group	Computation and Knowledge	Application of Skills	Application of Concepts	Interpretation and Evaluation	Application of Patterns and Relationships
Overall Mean	60.66	54.25	49.16	54.18	50.73
Overall SD	17.7	26.9	20.0	25.6	20.7
Overall Ranking	1	2	5	3	4
School 1 Mean	58.61	52.04	51.79	55.71	47.44
School 1 SD	16.2	29.2	16.8	28.5	19.8
School 1 Ranking	1	3	4	2	5
School 2 Mean	61.54	52.94	54.4	55.29	61.09
School 2 SD	23.1	30.6	21.7	20.7	24.7
School 2 Ranking	1	5	4	3	2
School 3 Mean	64.23	60.06	39.17	50.00	48.85
School 3 SD	15.8	17.1	22.2	23.9	14.8
School 3 Ranking	1	2	5	3	4

Overall, across all schools, the obvious strength is 'Computation and Knowledge' and the weakest category is 'Application of Concepts'.

5.2.2 Achievement: School Comparison Pre Test

As shown in Table 5.1 the top ranking achievement category, 'Computation and Knowledge', is the same for each school, scoring over 60%. The relative rankings of the other achievement categories differs for each school, with School 1 weakest on 'Application of Patterns and Relationships, School 2 weakest on 'Application of Skills' and School 3 very weak on 'Application of Concepts'. However, an ANOVA showed no Pre Test significant differences in performances between schools in any of the categories.

5.2.3 Achievement: Gender Comparison Pre Test

T-tests of the five process categories indicated that the males always scored higher than the females in the Pre Test but this difference was only significant (at the 0.05 level) in the 'Application of Skills' category. In this category the mean male score was 60.2 whereas the mean female score was 47.5.

Within each school, only School 2 offered any significant difference in performance between males and females but there were many interesting comparisons.

At School 1, for the 'Application of Skills' category, the mean male score was 65.1 whereas the mean female score was 42.3.

At School 2 there was an opposite trend where the females always scored higher than the males but this difference was only significant ($p = 0.017$) in the 'Applications of Patterns and Relationships' category. It was noted that most male standard deviation scores at this school were high indicating a wide range of abilities.

At School 3 the males always scored higher than the females and was not significant (at the 0.05 level) in any category.

5.2.4 Achievement: Ability Comparison Pre Test

The one-way ANOVA test was run on the Pre Test achievement scores of the ability sub-groups (low ability, intermediate ability, high ability). Even though the groups were divided on the basis of total Pre Test score, the results showed that a significant difference existed between the different ability levels in all of the achievement factors ($p = 0.000$ for each factor). So these three ability levels were at different proficiency levels.

5.3 Post Test Achievement Results

5.3.1 Achievement: Profile Post Test

The achievement profile of means and standard deviations for the Post Test is displayed in Table 5.2 below. All means are percentages.

Table 5.2 Achievement Profile; Overall and School Groups Post Test %

Group	Computation and Knowledge	Application of Skills	Application of Concepts	Interpretation and Evaluation	Application of Patterns and Relationships
Overall Mean	51.02	44.88	52.53	40.76	31.45
Overall SD	18.3	17.6	22.3	18.5	15.8
Overall Ranking	2	3	1	4	5
School 1 Mean	51.28	45.46	49.70	38.10	30.04
School 1 SD	18.6	17.4	22.5	19.7	15.4
School 1 Ranking	1	3	2	4	5
School 2 Mean	51.13	46.52	54.41	45.88	38.46
School 2 SD	21.2	23.2	23.8	19.7	20.4
School 2 Ranking	2	3	1	4	5
School 3 Mean	50.39	42.27	56.88	42.00	28.46
School 3 SD	15.9	12.6	20.9	14.4	10.3
School 3 Ranking	2	3	1	4	5

Overall, across all schools, the strength is 'Application of Concepts' and the weakest category is 'Application of Patterns and Relationships'.

5.3.2 Achievement: School Comparison Post Test

As shown in Table 5.2, the top ranking achievement category, 'Application of Concepts', is the same for two of the three schools, scoring over 50%. Note, however, that no mean score was above 60% for any achievement category for any school.

The relative rankings of the other achievement categories are basically the same for each school. As per the Pre Test, an ANOVA showed no Post Test significant differences in performances between schools in any of the categories.

5.3.3 Achievement: Gender Comparison Post Test

T-tests of the five process categories indicated that the males scored higher than the females in all categories except the 'Computation and Knowledge' category. In this category the mean male score was 50.9 whereas the mean female score was 51.1. In all categories, none of the overall gender differences were significant.

At School 1, the only category in which females scored higher was in the 'Interpretation and Evaluation' category, where the mean male score was 37.8 and the mean female score was 38.3.

Even though at School 2 the females scored higher than the males in every category, all of the gender score differences were not significant. As per the Pre Test, most male standard deviation scores at this school were high indicating a wide range of abilities.

At School 3 the males always scored higher than the females and it offered the only significant gender difference in scores ($p = 0.003$) for the 'Interpretation and Evaluation' category.

5.3.4 Achievement: Ability Comparison Post Test

The one-way ANOVA test was run on the Post Test achievement scores of the ability sub-groups (low ability, intermediate ability, high ability). As with the Pre Test analysis, the results showed that a significant difference existed between the different ability levels in all of the achievement factors ($p = 0.000$ for each factor). So these three ability levels were still at different proficiency levels.

5.4 Comparisons Between Achievement Pre Test and Post Test

5.4.1 Achievement Differences

In order to compare achievements before the school year began and at the end of the school year for each of the schools, columns were added to the data table for differences between Pre and Post totals for each of the five achievement areas. An analysis of these differences gives rise to the following observations.

5.4.2 Achievement: Profile Comparisons Pre and Post

Table 5.3 below shows the means and standard deviations of the differences for each achievement area before the school year began and at the end of the school year overall and for each of the schools.

Overall, across all schools, all categories except 'Application of Concepts decreased in mean score. The category which had the greatest decrease overall was 'Application of Patterns and Relationships'. The category that had the lowest decrease was 'Application of Skills'.

Table 5.3 Difference in Post-Pre Achievement Profile; Overall and School Groups (%)

Group	Computation and Knowledge	Application of Skills	Application of Concepts	Interpretation and Evaluation	Application of Patterns and Relationships
Overall Mean	-9.64	-9.37	3.38	-13.4	-19.28
Overall SD	15.5	21.6	24.0	27.5	15.5
Overall Ranking	3	2	1	4	5
School 1 Mean	-7.33	-6.59	-2.08	-17.62	-17.40
School 1 SD	15.8	22.7	17.8	30.3	15.7
School 1 Ranking	3	2	1	5	4
School 2 Mean	-10.41	-6.42	0.00	-9.41	-22.62
School 2 SD	14.6	20.2	27.9	18.9	15.0
School 2 Ranking	4	2	1	3	5
School 3 Mean	-13.84	-17.79	17.71	-8.00	-20.39
School 3 SD	15.3	19.1	27.1	27.1	15.6
School 3 Ranking	3	4	1	2	5
Non Booklet Schools Mean	-12.27	-12.53	9.57	-8.65	-21.4
Non Booklet Schools SD	14.9	20.2	28.5	23.4	15.2
Non Booklet Schools Ranking	3	4	1	2	5

5.4.3 Achievement: School Comparisons Pre and Post

Table 5.3 shows similar patterns for changes in scores for each category at each school. Comparing Tables 5.1 and 5.2, overall, the weakest category, 'Application of Concepts', became the strongest category with a minor shuffle in the other categories. Paired samples t-tests revealed that all mean decreases were significant ($p = 0.022, 0.000, 0.000, 0.001$) and the mean increase in 'Application of Concepts' was also significant ($p = 0.000$).

5.4.3.1 School 1 Achievement Comparisons Pre and Post

Tables 5.1 and 5.2 show that the only basic change in rankings for School 1 was that the category 'Application of Concepts' went from fourth to second highest and the category 'Interpretation and Evaluation' went from second to fourth highest. Note also that all category scores decreased in value.

Paired samples t-tests revealed that the mean score decreases were significant for the categories of "Computation and Knowledge', 'Application of Concepts', 'Application of Patterns and Relationships' and 'Application of Skills' (all p = 0.000).

5.4.3.2 School 2 Achievement Comparisons Pre and Post

Tables 5.1 and 5.2 show that the main changes for School 2 is the improved ranking of 'Application of Concepts' and decreased ranking of "Application of Patterns and Relationships'.

Paired samples t-tests revealed that the mean score decreases were significant for the categories of "Computation and Knowledge' (p = 0.000), 'Application of Skills' (p = 0.001). 'Interpretation and Evaluation' (p = 018) and 'Application of Patterns and Relationships' (p = 0.000).

5.4.3.3 School 3 Achievement Comparisons Pre and Post

School 3 was the main contributing factor for the overall change in the category, 'Application of Concepts' (mean increase = 17.71), with it also changing from the weakest to strongest category at School 3.

However, paired samples t-tests revealed that the mean score decreases were only significant for the "Computation and Knowledge' (p = 0.015) category.

5.4.4 Achievement: Comparisons Pre and Post – Booklet / NonBooklet

Table 5.4 shows the means and standard deviations of the differences for each achievement category for the school that used Booklets (N = 42) and those schools that didn't use Booklets (N = 37).

Table 5.4 Difference in Post-Pre Achievement Profile; Booklet / NonBooklet

		Mean	SD	t	p
Difference in Computation and Knowledge	Booklet Use	-7.3260	15.8424	-1.422	0.159
	Booklet Non-use	-12.2661	14.8916		
Difference in Application of Skills	Booklet Use	-6.5863	22.7350	-1.222	0.225
	Booklet Non-use	-12.5307	20.1594		
Difference in Application of Concepts	Booklet Use	-2.0833	17.7792	2.207	**0.030**
	Booklet Non-use	9.5721	28.5292		
Difference in Interpretation and Evaluation	Booklet Use	-17.6190	30.3484	1.457	0.149
	Booklet Non-use	-8.6486	23.3563		
Difference in Application of Patterns and Relationships	Booklet Use	-17.3993	15.6690	-1.153	0.253
	Booklet Non-use	-21.4137	15.1841		

From Table 5.3 it is clear that the school using Booklets and the two schools not using Booklets had a similar pattern of score changes throughout the year. Table 5.4 shows that there is only one significant difference during the year between the two instruction types. Schools 2 and 3, not using Booklets, were significantly better (p = 0.030) than School 1, using Booklets, in the 'Application of Concepts' category.

5.4.5 Achievement: Comparisons Pre and Post – Gender

Table 5.5 shows the means and standard deviations of the differences for each achievement category for all the males (N = 42) and the females (N = 37).

Table 5.5 Differences in Post-Pre Achievement Profile; Male / Female Overall

		Mean	SD	t	p
Difference in Computation and Knowledge	Male	-12.8205	16.6173	-1.979	0.051
	Female	-6.0291	13.4628		
Difference in Application of Skills	Male	-13.6673	19.6858	-1.912	0.060
	Female	-4.4928	22.9572		
Difference in Application of Concepts	Male	10.8135	25.1698	3.091	**0.003**
	Female	-5.0676	19.7187		
Difference in Interpretation and Evaluation	Male	-13.8095	27.4042	-0.134	0.894
	Female	-12.9730	27.9747		
Difference in Application of Patterns and Relationships	Male	-17.7656	14.4648	0.925	0.358
	Female	-20.9979	16.5825		

There is only one significant difference between the males and females across all schools. Table 5.5 indicates that the males had a significant increase ($p = 0.003$) in test performance over the females throughout the year when it comes to 'application of concepts'.

Similar independent samples t tests to Table 5.5 were conducted to compare males and females at each individual school throughout the year. The only school to show any significant difference in achievement between the males and females was School 1. Here the females had a significant ($p = 0.023$) improvement in achievement as compared to the males when it came to 'application of concepts'.

As well, performances for each gender were considered throughout the year for the Booklet school and the NonBooklet schools. No significant gender differences in achievement were found in either group.

5.4.6 Achievement: Comparisons Pre and Post – Ability Levels

An ANOVA on each of the three ability groups was done for their Pre and Post Tests. Table 5.6 (next page) shows the means and standard deviations of the Pre and Post percentage differences for each achievement category for the three ability levels:- low ability (Booklet

N = 15, NonBooklet N = 11), intermediate ability (Booklet N = 13, NonBooklet N = 12) and high ability (Booklet N = 14, NonBooklet N = 14).

Table 5.6 % Differences in Post-Pre Achievement Profile for Ability Groups; Booklet / NonBooklet

		Low Ability				Intermediate Ability				High Ability			
		Mean	SD	t	p	Mean	SD	t	p	Mean	SD	t	p
Difference in Totals	Booklet Use	-5.3333	6.488	0.336	0.739	-9.0769	7.466	0.959	0.347	-15.7143	9.918	0.072	0.943
	Booklet Non-use	-6.3636	9.157			-12.0000	7.769			-16.0000	11.066		
Difference in Computation and Knowledge	Booklet Use	-7.1795	11.798	0.294	0.772	-10.0592	17.593	0.565	0.578	-4.9451	18.503	1.334	0.194
	Booklet Non-use	-8.3916	8.034			-14.1026	18.213			-13.7363	16.298		
Difference in Application of Skills	Booklet Use	4.8485	16.446	1.494	0.148	-1.1988	21.624	1.103	0.282	-23.8404	20.168	-0.610	0.547
	Booklet Non-use	-5.7851	19.827			-10.7143	21.484			-19.3878	18.447		
Difference in Application of Concepts	Booklet Use	-3.3333	18.714	-1.350	0.190	-3.8462	18.119	-2.723	**0.012**	0.8929	17.387	0.069	0.945
	Booklet Non-use	10.2273	32.348			19.792	25.008			0.2976	27.026		
Difference in Interpretation and Evaluation	Booklet Use	-1.3333	27.740	0.055	0.957	-16.9231	28.102	-0.166	0.869	-35.7143	26.228	-2.832	**0.009**
	Booklet Non-use	-1.8182	10.787			-15.0000	29.695			-8.5714	24.450		
Difference in Application of Patterns and Relationships	Booklet Use	-12.3077	12.937	-0.364	0.719	-13.6095	18.119	1.082	0.290	-26.3736	16.447	0.912	0.370
	Booklet Non-use	-10.4895	12.052			-19.8718	14.469			-31.3187	11.865		

When it comes to achievement changes, there are no significant differences for low ability students between those that use Booklets and those that don't. The low ability Booklet students did, however, improve in one area - their ability to apply skills. The only category that the low ability NonBooklet students improved in was their ability to apply concepts. For intermediate ability students, those that do not use Booklets have a significant improvement (p = 012) in 'application of concepts' compared with those that use Booklets. In all other categories, all intermediate ability students attained lower achievement levels at the end of the year.

The high ability students, when compared to the other two groups, had rather large decreases in achievement, in one case dropping 35.7% throughout the year. Yet all high ability students were still able to apply concepts and even show slight improvement. While all high ability students showed decreased performance in the 'interpretation and evaluation' area, the NonBooklet students were still significantly better ($p = 0.009$) than the Booklet students.

6 Overall Comparisons of Learning Environments

6.1 Comparisons at the Beginning

It is important to gain an insight into the attitude and ability levels of the students as the study begins. The first Attitude Questionnaire and Pre Test gave us the following picture of the students in the schools under study.

Regarding gender differences between the two systems, there were basically no overall differences in either attitudes or achievements between the Booklet and NonBooklet schools. The only minor difference was that the females developed a significantly more positive perception of the value of mathematics than the males.

There were also no gender differences or attitude differences found between ability groups at the beginning of the year. Despite the expected trend in higher ability students having a higher interest in mathematics, it appears that all students were unaware of their own ability.

However, ignoring gender, there were some noticeable differences in attitude between the systems.

The Booklet school began with students having a significantly higher positive attitude to other students yet significantly lower positive perception of their own ability than those in the NonBooklet schools.

There was also a wide-ranging significant difference between all schools to begin with in the students' perception of their teacher's attitude to the students in their class, with those students in the Booklet school being the least positive. Yet these Booklet students were similar in their attitude to those at one of the NonBooklet schools in their perception of their teacher's classroom management skills.

As far as achievement is concerned, all students scored well initially on 'Computation and Knowledge'. While males always scored higher than females, there were no Pre Test significant differences in performances between gender, or all students in general, between schools in any of the categories.

6.2 Comparisons at the End

As the year progressed different scenarios developed to create differences between the Booklet and NonBooklet schools.

The first obvious change is that, overall, there is a general, slight decrease in positive attitude across almost all factors. Yet, when comparing the two systems, opposite trends occur in every factor (Table 4.7). Whereas the students in the Booklet school develop a more positive attitude for a particular factor, the students in the NonBooklet school develop a more negative factor. This was an unexpected result.

The Booklet system has a more flexible approach to homework. It is interesting then that, while not significant statistically, the students at School 1, the school using Booklets, developed the greatest decrease in attitude to homework, while the attitude to homework of those students using textbooks actually increased slightly.

The Booklet system also operates in an environment of less up-the-front teaching and more individual help. The Year 9 students using Booklets appeared to perceive this as slightly improving classroom management and slightly improving their perception of their teacher's attitude to them as students. The NonBooklet Year 9 students basically had the opposite attitude, with one school having no attitude change to classroom management (mean of pre/post = 0.0000) and the other school giving these two categories the lowest rankings in attitude changes. So in this area the Booklet system appears to have created a positive

effect. Yet this same open environment cannot explain why the Booklet students developed a more negative attitude to other students.

The mathematics students at all schools had a Booklet or text with answers supplied. Yet the students from the Booklet schools had a significantly better outlook on their own ability by the time they got to the end of the school year when compared to the NonBooklet students, who actually showed the greatest decrease in attitude throughout the year.

It would be expected that a student's perceived value of a subject would relate positively to their perception of their own ability. However, this is not evident in this study. The students from the NonBooklet schools significantly improved their perceived value of Mathematics when compared to those at the Booklet school, who actually showed a slightly more negative attitude.

There is much less difference between the two systems in the area of achievement. While practically all students from both systems had significant decreases in scores from Pre Test to Post Test, the only perceivable achievement differences between the students from the two types of mathematics instruction was in the 'Application of Concepts' category. The students from the NonBooklet schools were significantly better at doing this. While the females were significantly better in this category than the males at the Booklet school, the males were significantly better overall at applying concepts as the year progressed. This implies that the improved performance at the NonBooklet schools was mainly due to the males at these schools.

The three Pre Test subdivisions on the basis of abilities were significantly maintained in the Post Test. Generally, the students in each ability level stayed in their ability level throughout the year regardless which system they were under. There were only two significant differences between ability groups between systems. The intermediate ability,

NonBooklet students were significantly better at improving their 'application of concepts' than the intermediate ability, Booklet students. Also, the high ability, NonBooklet students were significantly better at not losing their 'interpretation and evaluation' skills than the high ability, Booklet students.

7 Conclusions

This paper has concentrated on the influence of the Booklet System on a student's mathematical performance and attitude. Of the eleven goals of the Booklet System listed in Appendix 3, this study has produced results that enable comment to be made on five of them:- motivation, homework, ability, learning readiness and mathematical anxiety (relating to self-confidence).

This study has shown no major differences in academic performance between the students in the Booklet and NonBooklet Systems both at the beginning and the end of the school year. There were no gender differences and no ability differences between systems. Most students in their ability level generally maintained their ability status as the year progressed, regardless of which system they were under. The only two significant differences noted academically throughout the year were between ability subgroups. Thus the Booklet System may cater for students of varying ability but, according to this study, it certainly does not give them an advantage over those students not doing booklets.

In the realm of attitudes, there were once again no gender or ability differences between systems. However, ignoring gender and ability and regarding the students from each system as a unit, there were appreciable differences between the systems.

Students from the Booklet school developed the greatest decrease in attitude to homework implying that the Booklet goal of having a better approach to homework has not been achieved. They also lowered their perceived value of their Mathematics teacher and Mathematics in general, yet they improved their attitude to the teacher's abilities and teacher's attitude to them. This implies that the Booklet students were happy with their teacher but not the subject.

Interestingly, they recorded the greatest increase in outlook of their own ability despite being no better academically than the NonBooklet students. At the same time, despite a more interactive classroom atmosphere being employed under the Booklet System with much individualized instruction and peer help occurring, a more negative attitude to other students was shown by the Booklet students.

These results would imply that the Booklet students were possibly more self-confident and better motivated with less anxiety and were more ready to learn, all of which tend to reinforce these particular goals of the Booklet System. Yet factors of tolerance and cooperation with others were not developed by the Booklet students.

Considering that in every attitude category the results for the NonBooklet students were just the opposite, it does indeed appear that the Booklet System is successful in motivating students, helping them to be ready for learning and to have a better outlook about themselves. However, this improvement in attitude does not lead to the Booklet students achieving any better academically than the NonBooklet students.

As we move into the new century, the needs for mathematics skills will be greater than ever. To prepare students for the workplace demands they will face and to compete in today's information-based world economy, students will need to analyze data, think logically, make decisions, develop more positive attitudes, work individually and in groups and solve real life problems. Advocates of the Booklet System claim that its main intention is to bring about these changes and to create an improved method for mathematical learning. This study has shown that, while the Booklet System can improve a student's attitude about their progress in Mathematics, it has not helped their attitude about others, nor their ability and performance in Mathematics. In these respects this study agrees with the conclusions mentioned earlier in previous studies on page 4 by Rickards (2003), page 7 by Gudan (1995) and page 8 by Rasberry and Turner (1988).

8 Limitations and Future Research

Some limitations of the study may have affected its results. One limitation of the study was the small sample size, which does not allow for confident generalizations to other school contexts. Another limitation was the time period over which the respective different learning environments took place. This may not have been long enough to show a real difference in outcomes with respect to the two learning environments. A third point of concern relates to the measuring instruments. While the 'attitude' measuring instrument seemed to be useful and appropriate, the 'achievement' measuring instruments, particularly the Post Test, may not have been appropriately pitched at the right level to pick up relevant improvements in knowledge, skills and other abilities.

Research into the use of self-directed Booklet systems is very limited and still lacking. Future research needs to include studies consisting of a larger number of subjects at various academic levels and stretching over a longer period of time for one to be able to confirm the findings of this research. Furthermore, it would be advantageous for future research to include longer-term case studies, where the students' attitudes could be teased out by means of interviews and focus groups.

Despite some positive effects being created by the Booklet system, parents perceived that the reduced up-the-front teaching and lack of textbooks were hindering their children from achieving. After a deal of correspondence to administration, School 1 ceased to use the Booklet System at the end of 2004. Teachers at another school that used to use Booklets reported a similar occurrence that caused them to change from Booklets to textbooks at the end of 2003. This was the school that originally agreed to participate in this study but pulled out just before the study commenced in 2004.

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10 Appendices

Appendix 1 What is the Booklet System?

The Booklet System is:-

- a series of small booklets with short, easy to read explanations with sample solutions and then an exercise of questions with answers.
- each booklet is about 4-6 lessons of work.
- a first step in a teacher-facilitated program for students to learn Mathematics.
- future steps involve complementing book learning with computer-based lessons.

The Booklet System is NOT students:

* just working at their own pace.

* working if they feel like it.

* playing around with puzzles, games or doing experiments.

* re-inventing Mathematics.

The Booklet System IS students:

* reading a simple explanation of a new Mathematics skills or concept.

* studying sample solutions.

* doing exercises of questions and following the required setting out.

* marking their own work from Booklet answers and solutions.

* keeping up-to-date with the timeline of weekly deadlines.

* doing and marking diagnostic Booklet Tests on each booklet on their own.

Appendix 2 Advantages of the Booklet System

The Booklet System is able to:-

- Provide students with a comprehensive structure and detailed expectations.
- Reinforce mathematical concepts effectively
- Treat students with freedom to choose their own level of commitment.
- Allow students to proceed as fast as they like through each term's work.
- Provide extension material for all students completing work ahead of schedule.
- Actively encourage students to take responsibility for fulfilling weekly deadlines.
- Allow students the TIME to do lots of their own Mathematics every day, in class.
- Ensure that each booklet is a small achievable goal.
- Teach time management skills
- Cater for different ability levels in one classroom with one teacher.
- Cater for individual rates of learning. A skill can be grasped in a few minutes or a few lessons. Struggling students receive individual help.
- Force students to actively pursue understanding through reading. Re-reading takes place until the new skill is grasped.
- Allow for wide variation of learning readiness.
- Supply constant individual attention that helps struggling students with basic skills and talented students with problem-solving skills leading to improved understanding and achievement.
- Reduce Mathematics anxiety in that students are never publicly asked questions in order to discipline them to pay attention. Students can ask the 'Booklet Teacher' over and over without a 'negative teacher response'.
- Reduce discipline problems by creating a very positive classroom.
- Net lazy students.
- Support inexperienced teachers as the resources and experience of the best available teachers are used to develop lessons for all students.
- support a flexible Curriculum where topics can be spiralled often, suitability of questions can be improved and Senior topics (Yr 11,12) can be fed down to Junior school (Yrs 8, 9, 10) to create a more free flowing gradation as a student progresses from Junior Mathematics to Senior Mathematics.

Appendix 3 Elaboration of Goals of the Booklet System

The following is a summary of the contents of a document in the teacher's materials accompanying the Booklet System package.

1 Increase Motivation

HOW DO WE RELEASE THAT 'ENERGY'?

There are many, many wonderfully devoted and highly skilled and highly successful conventional teachers. **However, this Junior Mathematics program proposes that this type of conventional teaching should be a small part of a student centred type of learning.**

This program is an effort to stop teachers taking 'centre stage' and to let kids learn!

Give students CONTROL! (more control!)
Give students FREEDOM! (with structure)
Give students a chance to make a personal commitment!
Give students CENTRE-STAGE!

WE NEED TO FOCUS OUR COMBINED ENERGIES ON HOW TO PROVIDE STRUCTURES THAT WILL FACILITATE THE LEARNING OF MATHEMATICS.

2 Harness Student Power

Using the booklets to replace teacher explanations we:

TREAT STUDENTS WITH FREEDOM AND STRUCTURE

THE BOOKLET SYSTEM PROVIDES STRUCTURE BUT ALLOWS STUDENTS THE FREEDOM TO CHOOSE THEIR OWN LEVEL OF COMMITMENT

The Booklet classroom is one of student activity, learning facilitated by the teacher. **Students <u>are</u> really keen to pursue Academic Excellence**. Because students are permitted the freedom to work as hard as they like, we are able to unlock that vital energy that comes with the enthusiasm of a personal commitment.

It is not true to say that students work at their own pace in the Booklet System. There are weekly deadlines and a lunchtime tutorial system that quickly nets the lazy or uninterested student. Through peer-pressure, tutorial follow-up and careful test setting we try to early set all students into a success cycle.

Students can choose their level of commitment. However, when they choose a low level of commitment, we try through a balance of expectation and success to increase their level of commitment.

3 Flexible Homework Structure

Because of the time that it takes for a teacher to present new material in a traditional "teacher-talk" setting, **the requirement of daily homework is vital to a student's success.** Students who fail to do regular homework - FAIL! Unfortunately, **homework is often a monotonous daily routine for many students.** It can be done "mindlessly" so "I won't get into trouble".

Following up homework is another time-consuming procedure that must be done in a conventional class. Often there are difficult questions that need attention. Often discipline is required to ensure that homework is being done.

Because reading is such an efficient method of learning in the Booklet system, our booklet students are doing Mathematics themselves for most of every lesson. We estimate that for four, 50 minute lessons of Mathematics per week, **students would be "doing Mathematics questions themselves" for approximately 3 hours a week** in class. The amount of homework then depends on the amount of work done in class.

There are, again, wide individual variations on the amount of homework students are capable of doing. **Our students have a choice as to the level of commitment to their homework**. The majority of students relish this freedom and readily adjust, during Year 8, to **the goal of always staying "ahead"** (of the timeline deadlines). Students have told me that they make a big effort on 2 or 3 nights and other nights are for other commitments. Fine! **There are students who do no homework, ever!** Thus the **teacher now only has a weekly deadline to follow up.**

Expected routines help eliminate the elements of confrontation that foster rebellion and destroy positive enthusiasm.

Yes, there is **the failure cycle.** Repeated failure, year after year is very damaging to a child's self-confidence. Children label themselves as failures. Failure becomes an expected outcome. Yet, "struggling students" **can cope with the course without doing homework! They are expected to sit and do their own Mathematics every lesson every day.** Through careful test setting in first term, we try to ensure some early success. **This amount of regular Mathematics (about 3 hours/week) is often enough to pull struggling students out of the failure cycle, into the "positive attitude and success" cycle.** There are many students I have taught, in my lifetime, who would have succeeded if only they done a little work!

The Booklet System ensures that ALL students WORK! WORK! WORK! This is the real key to their becoming "good at Mathematics". Just plain old-fashioned hard work!

Also when students can do lots of Mathematics, over many weeks and years, they gain lots of experience with a wide variety of skills, in a wide variety of contexts, then those students become proficient at Mathematics. For some students the highest level of proficiency is to be able to calculate Discounts, Areas, Volumes, Tax, etc.

More talented students can use their mathematical skills to analyse and solve complex real world problems. This process is the making of a mathematician! Our students become confident and enthused with their skills in Mathematics.

4 Catering For Different Ability Groups

Problem of Conventional Class Teacher:

How do I cope with remedial students, average students and gifted students and still cover the course requirements for all of the class?

Booklet Advantage

1. **Capable students** can work through the basic course as fast as they like. They cope easily with and prefer learning through reading. They are **never held back by struggling students who are in their class.** Once a capable student has finished a term's work they then start on the extension booklets. Capable students are not bored. Their enthusiasm is maintained and fostered. There are plenty of rewards for the capable student.

   The advanced course booklets are written for the capable student. Each booklet has its challenges.

   Through early "feed-down" of advanced mathematics topics, we are able to provide an exciting course for our capable students and lead them to a much higher level of development than conventionally taught classes of the same age. This preparation is a foundation on which Senior Mathematics can be strongly consolidated.

2. **Average students** find they can keep up with the required timeline, without too much stress. They have plenty of opportunity for individual help. They may not get ahead or do extra work. However they cope well with the course requirements.

3. **Struggling students** need a lot of individual coaching. The Booklet System allows for this every lesson. Struggling students often need more time on a concept, the flexibility of the Booklet System allows for this. Struggling students do not have to do all the questions in each booklet. The system is flexible enough for teachers to select suitable levels of achievement for students of lower ability. Struggling students are less likely to give up with this support available to them.

5 Learning Readiness

AN "AGE-OLD" PROBLEM WITH CONVENTIONAL "UPFRONT" TEACHING

Despite the most experienced teacher's best efforts, students often "tune-out". Maybe not all students all of the time, but certainly all students some of the time and some students all of the time!

BOOKLET ADVANTAGE

The student HAS to actively pursue understanding. The student has to read, re-read until that golden moment of "psychological readiness " occurs, active thought takes place and a concept or skill "digested".

In conventional teaching where we teachers try to fore-warn, pre-empt, over-direct our students' learning pathways, the opportunity for "real" understanding is often smothered with too much "mothering".

It is often the case that as a student tries an exercise and stumbles that she is then psychologically ready to learn. As she then reads again the explanation of a method or concept, she can begin to understand the mathematical process. The timing of this learning process occurs with high individual variations. The Booklet System allows for this variation of learning readiness. Inherited ability, physical health, emotional stress, fear of failure, level of self-confidence - these are some of the factors that can contribute to the wide variation of learning readiness.

The Booklet System allows for flexibility. All students in the class do not have to learn the same concept at the same time in the same amount of time. The Booklet System requires that "active thinking" take place more often.

6 Supports New Teachers

ANOTHER PROBLEM OF A TRADITIONALLY TAUGHT MATHEMATICS

There is a wide range of experience amongst Mathematics teachers. **Most schools need to use a "non-Mathematics" trained teacher** to teach some Junior Mathematics classes. Students can arrive into a Senior Mathematics class with a variety of gaps in their knowledge.

BOOKLET ADVANTAGE

All Junior classes are receiving the same weekly input of lessons. The material is presented in an easily readable level by experienced Mathematics teachers. All classes are following an identical program. Students will not be unduly disadvantaged by having a "non-Mathematics" teacher. Students arriving into a Year 11 class will all have covered the same course, all sat the same tests and exams.

7 More Efficient Use Of Classtime

Yes, there is value in blackboard teaching, discussion and the old-fashioned teacher directed learning path. But it takes TIME - a lot of TIME.

The bright students can get bored and the weak students can get lost. The students may get frustrated, the teacher may end up using a lot of energy teaching, disciplining, teaching, talking, disciplining.

We can write our explanations down so students can read and understand. Of course, the adequacy of the explanation and quality of examples and exercises is crucial to success. Students do not have to rely on the teacher for all explanations. Students are empowered to learn mathematics by themselves. This is far more time efficient than all oral teaching. Bright students can proceed as fast as they can comprehend the material. Struggling students can repeat a harder concept.

8 Flexible Curriculum

LIMITATIONS OF A TEXT BOOK

When, because of financial considerations, a school must use a textbook series for many years, the curriculum content can become very "old fashioned". Textbooks are written in difficult language often with gaps, fully intended to be explained by a teacher.

Teachers are at times frustrated with topics being left out altogether, topics not being challenging enough, topics not being spiralled often enough, sets of exercises not being graded well enough, etc.

There are many reasons why we teachers have had to work hard to overcome the weaknesses of a set of textbooks. Then you can get parents who complain vigorously that the teacher is changing the course, because you have presented material not in the text!

That textbook has such authority! In fact, even brighter students often won't take seriously material that is seen as an extra and not really part of the course because it is not in the textbook.

BOOKLET ADVANTAGE

The Booklet System is wonderful with the freedom it gives us to constantly keep updating and refining our curriculum.

* We can "feed down" all the latest Senior syllabi changes into junior years.
* We can spiral topics as often as we like.
* We can change exercises to include easier and harder questions.
* We can listen to students and alter our explanations based on their feedback.
* We can include all the best ideas from our best teachers, so that the wisdom of our experienced teachers is shared for all to use. Booklets can multiply the talents of our "top teachers".

9 Economic Benefits

Textbooks provide a lot of resource material but are in general not easily understood by students. It is expected that a teacher should interpret and reveal the mysteries. Once a school has bought a series of texts, financial considerations demand that they be 'lived" with for many years. Teachers did lots of "teaching", lots of sheets, lots of drill to help students through the textbooks. The class in general had to move together as a group.

However, for a fraction of the cost of a textbook, we can photocopy and staple together small booklets of material for students. Counting cost of materials, authoring, typing and collating it costs 25 cents per booklet. That's $7.50 a year for 30 booklets. If you are copying an established booklet and typing costs are not included, it costs 10 cents per booklet for paper and collation. That's $3.00 per year for set of 30 booklets.

We collect booklets at the end of a year. We find about 90% are reusable. We charge students $1.00 for damaged or defaced booklets. The booklets can be reused for about 4-5 years.

10 Better Use of Teacher Input

In the Booklet System a teacher's time is used to help individuals.

In a mixed ability class, struggling students receive constant personal help.

In a streamed class of better students, the teacher's time can be in guiding students through problem solving and questions that require higher order reasoning.

If we think of learning Mathematics in 3 stages:

1. Introducing new skills, new concepts;

2. Practice in simplified settings; and

3. Problem solving, combining the new routine with other routines in a variety of contexts.

When I taught in a traditional classroom, I would mainly cover stages 1 and 2, generally due to the time pressure to cover the course.

I prefer to concentrate my attention on problem solving with students. The Booklet System has released my teaching from the daily grind of presenting new work, so that I can spend time with more talented students and support them as they "grapple" with some more challenging activities..

11 Reducing Mathematics Anxiety

Students working within the structure of a Booklet Mathematics Learning System are happier students! They are free from many of the stresses that are present in the teacher exposition lock-step style of learning. There are many aspects to this:-

* Students are in greater control of their own learning pace.

* Students are not going to be made to appear foolish in front of their peers - "The *teacher will never ask me a question in front of the class and embarrass me."* (Year 8 response)

* Students are streamed from Term 4 Year 8 so struggling students are protected and "made" to succeed! They are taught to attribute success to their effort.

* Booklets are better able to offer real mathematical understanding to children as full explanations are written out. Students tell me it's like having a teacher with you all the time, but the teacher never gets cranky with you!

* Methodology is clearly presented so that parents and guardians can tune-in to the required presentation and level of mathematics required.

* Booklets make it possible to write out full solutions for the answers so children can see they have most of the solution correct even if they got the answer wrong. This reduces

anxiety as students don't receive a total negative "reward" as the result of a minor error. This is particularly important in the Ordinary Mathematics level.

* Because the teacher is freed from the stress of teacher-exposition and the associated discipline, the teacher can consistently praise individual students for specific solutions or part solution.

* Self-confidence is well fostered in the Booklet classroom. An enormous amount of individual attention is available compared to traditionally taught classrooms. Students have more time - they do not have to jump to a new topic before understanding the topic at hand. Ordinary level students are given material at the right level so success is a sure result of effort.

* Capable students have much more time to explore mathematics applications. They are not locked into the pace of the middle student.

Appendix 4 Attitude Questionnaire

The next four pages contain a copy of the Attitude Questionnaire used in this study. The same one was administered accompanying both the Pre Test and the Post Test.

Appendix 5 Achievement Tests

At the back of this report is located the Pre Test (Mathematics 13) and the Post Test (Mathematics 14) used in this study.

ATTITUDE TO MATHEMATICS QUESTIONAIRE

NORTHPINE CHRISTIAN COLLEGE

Instructions

- We are interested in how you feel about mathematics.
- Please answer honestly and show a response to **every** question.
- These items don't have right or wrong answers.
- Clearly print your name below. Your teacher will give you a number after the test is collected.
- Circle Male if you are male or Female if you are female.

Name _____ Student Number | | | | |

School **Northpine Christian College**

Year Level 9

Sex Male / Female (circle one)

PRACTICE

Before you commence, practise on the sample below.

Place a circle around:

4 if you STRONGLY AGREE with the statement;
3 if you AGREE with the statement;
2 if you DISAGREE with the statement; and
1 if you STRONGLY DISAGREE with the statement.

I enjoy going to a good movie. 4 3 2 1

If you agree with this statement you would circle the 3.

4 - STRONGLY AGREE
3 - AGREE
2 - DISAGREE
1 - STRONGLY DISAGREE

19	My mathematics teacher will seldom help students who are having difficulty with schoolwork.	4	3	2	1
20	Activities in this mathematics class are carefully planned.	4	3	2	1
21	I am usually proud of the work I do in mathematics.	4	3	2	1
22	Some of the students in this mathematics class prevent me from working.	4	3	2	1
23	Our mathematics teacher seems to like most of the students in this class.	4	3	2	1
24	Doing mathematics homework helps me to understand the subject.	4	3	2	1
25	The thought of going to a mathematics lesson makes me feel good.	4	3	2	1
26	I don't expect to make much use of what I learn in mathematics.	4	3	2	1
27	My teacher is able to make mathematics easier to understand.	4	3	2	1
28	Boys are more likely to be asked to answer questions during our mathematics class.	4	3	2	1
29	In mathematics lessons I usually don't understand the work we are given.	4	3	2	1
30	I am happy to work with most of the students in my mathematics class.	4	3	2	1
31	I feel that I can speak to my mathematics teacher about things that are on my mind.	4	3	2	1
32	If I needed help to do my mathematics homework, I would not be able to get it.	4	3	2	1
33	I don't enjoy many of the activities we do in mathematics.	4	3	2	1
34	If I do well in mathematics it will help me to get a job.	4	3	2	1
35	My mathematics teacher embarrasses students who don't know the right answer.	4	3	2	1

4 - STRONGLY AGREE
3 - AGREE
2 - DISAGREE
1 - STRONGLY DISAGREE

PART A:

1	I usually like mathematics	4	3	2	1
2	I find mathematics less useful than other subjects.	4	3	2	1
3	My mathematics teacher does not allow me to work at my own speed.	4	3	2	1
4	My mathematics teacher always explains clearly what he/she would like us to do.	4	3	2	1
5	In my mathematics class I don't try to do work that I find difficult.	4	3	2	1
6	I like most of the students in my mathematics class.	4	3	2	1
7	My mathematics teacher is very understanding.	4	3	2	1
8	I can usually cope with the mathematics homework we are given.	4	3	2	1
9	Mathematics lessons are usually boring.	4	3	2	1
10	I feel that I learn a lot in mathematics.	4	3	2	1
11	The mathematic teacher usually arranges interesting things for us to do.	4	3	2	1
12	The teacher is not able to control the students in our mathematics class.	4	3	2	1
13	I can usually handle the work I am given in mathematics.	4	3	2	1
14	The students in my mathematics class don't pay attention to what the teacher is saying.	4	3	2	1
15	My mathematics teacher is not interested in whether or not the students can handle the work.	4	3	2	1
16	We get too much homework in mathematics.	4	3	2	1
17	Most things we learn about in mathematics are interesting.	4	3	2	1
18	What we do in mathematics will help me understand more of the world around me.	4	3	2	1

4 - STRONGLY AGREE
3 - AGREE
2 - DISAGREE
1 - STRONGLY DISAGREE

19	My mathematics teacher will seldom help students who are having difficulty with schoolwork.	4	3	2	1
20	Activities in this mathematics class are carefully planned.	4	3	2	1
21	I am usually proud of the work I do in mathematics.	4	3	2	1
22	Some of the students in this mathematics class prevent me from working.	4	3	2	1
23	Our mathematics teacher seems to like most of the students in this class.	4	3	2	1
24	Doing mathematics homework helps me to understand the subject.	4	3	2	1
25	The thought of going to a mathematics lesson makes me feel good.	4	3	2	1
26	I don't expect to make much use of what I learn in mathematics.	4	3	2	1
27	My teacher is able to make mathematics easier to understand.	4	3	2	1
28	Boys are more likely to be asked to answer questions during our mathematics class.	4	3	2	1
29	In mathematics lessons I usually don't understand the work we are given.	4	3	2	1
30	I am happy to work with most of the students in my mathematics class.	4	3	2	1
31	I feel that I can speak to my mathematics teacher about things that are on my mind.	4	3	2	1
32	If I needed help to do my mathematics homework, I would not be able to get it.	4	3	2	1
33	I don't enjoy many of the activities we do in mathematics.	4	3	2	1
34	If I do well in mathematics it will help me to get a job.	4	3	2	1
35	My mathematics teacher embarrasses students who don't know the right answer.	4	3	2	1

4 - STRONGLY AGREE
3 - AGREE
2 - DISAGREE
1 - STRONGLY DISAGREE

36	In our mathematics class, students who finish their work early are usually left with nothing to do.	4	3	2	1
37	In my mathematics class I usually try to do as well as I can.	4	3	2	1
38	Many of the students in my mathematics class just want to waste time.	4	3	2	1
39	Our mathematics teacher is not interested in our opinions.	4	3	2	1
40	My parents do not encourage me to do my homework.	4	3	2	1

PLEASE MAKE SURE YOU HAVE ANSWERED EVERY QUESTION

Mathematics 13

Name

Date of birth | | | | | | Boy ○

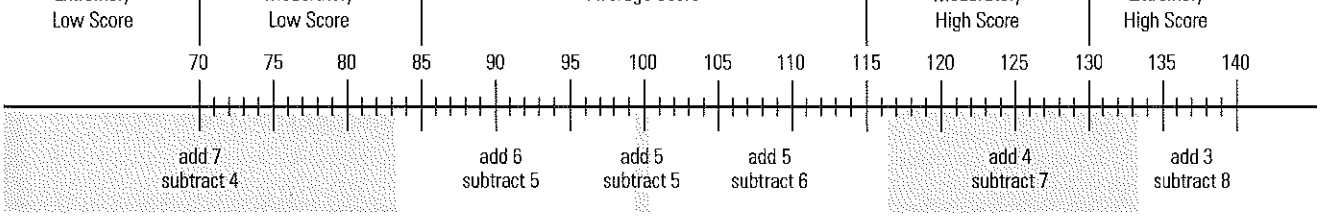
Date of test | | | | | | Girl ○

School

Class

Note to teachers
Fill in the boxes and mark the standardised score on the scale. Then add and subtract the numbers given for that region. Mark the interval with a broad horizontal line. This gives the 90 per cent confidence interval (you can be 90 per cent certain that the pupil's 'true score' is in this band). Full details are given in the Teacher's Guide in the chapter 'Interpreting and reporting test results'.

Age (years and completed months)	Raw Score	Standardised Score	Percentile Rank	Progress Score
:				



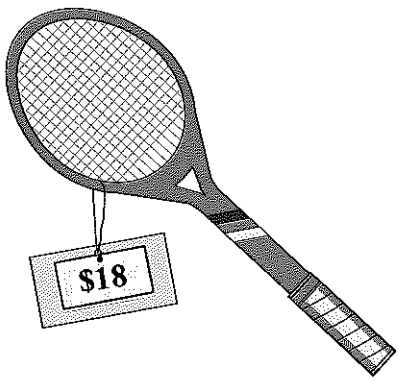
nferNelson
understanding potential

National Foundation for Educational Research

Calculator section

1

Eve is saving up to buy a tennis racket which costs $18.
She saves 75c each week.



How many weeks will it take her to save enough money?

Answer _____ weeks

2

Ali earns $8 an hour.

How much would he earn for 15½ hours work?

Answer $ _____

3

A ribbon which is 16.2 m long is cut into 15 equal pieces.

What is the length of each piece?

Answer _____ m

4

Lee thought of a number.

He doubled it and then added 19.3.

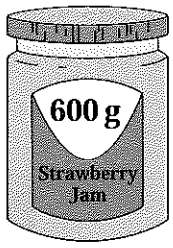
The answer was 68.7.

What was the number Lee thought of?

Answer _____

Go on to the next page

5 A canteen needs to buy 12 kg of strawberry jam.

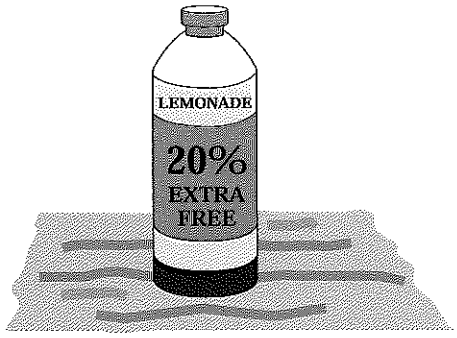


How many 600 g jars would they have to buy?

Answer _____ jars

6 A bottle of lemonade usually contains 2 litres.

A new bottle has **20% extra free.**



How many litres are in the new bottle?

Answer _____ litres

7 For which **whole number** value of x is the value of $x^2 + 2x$ closest to 75?

Answer _____

8 The owner of a garage buys 9 storage containers each costing $10.85.

How much change should the owner get from $100?

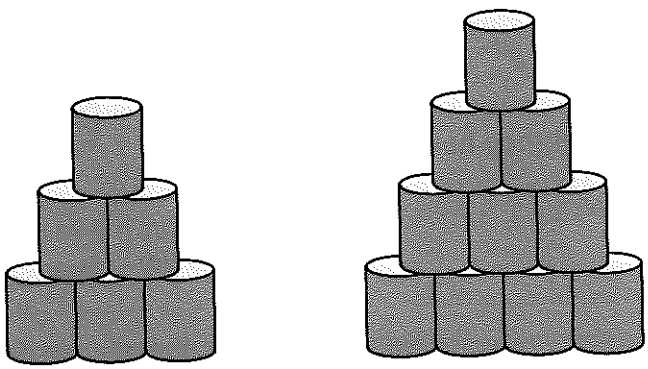
Answer $ _____

Go on to the next page

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Page total

9 In supermarkets you sometimes see tins stacked like this.



3 rows **4 rows**

The formula $T = \frac{R\,(R + 1)}{2}$ tells you the total number of tins (T) needed for a stack with R rows.

Work out how many tins are needed when R is 10.

Answer _____ tins

10 Ranjit buys a weekly magazine at \$1.80.
The price increases by one quarter.

Work out the **new price** of the magazine.

Answer \$ _____

11 An architect has made a model of a bridge to a scale of 1 : 50.
The actual bridge is 80 m long.

How long is the model bridge in centimetres.

Answer _____ cm

Go on to the next page

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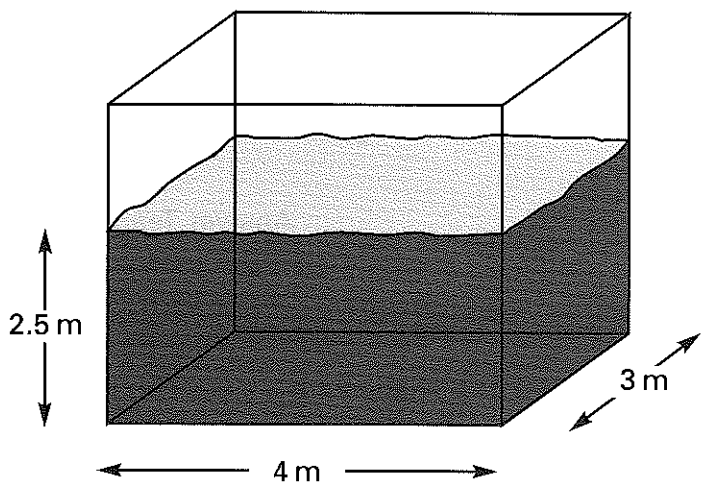
Page total

12 Write the correct number in the box.

$$70\% = \frac{\square}{20}$$

13 A large fish tank has a base measuring 4 m by 3 m.

It is filled with water to a depth of 2.5 m.



Work out the volume of water, in m^3, in the tank.

Answer _____ m^3

14 Alan is collecting cans for recycling.

Over a period of 8 weeks he collected the following numbers of cans:

14 7 15 16 11 8 17 8

Work out the **mean** number of cans Alan collected each week.

Answer _____ cans

Go on to the next page

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Page total

15 A record is kept of the score of six basketball teams for 15 matches.

The table below shows various statistics relating to these scores.

Team	Mean Score	Median Score	Lowest Score	Highest Score
A	83.5	81	74	92
B	81.3	84	71	90
C	72.8	75	63	84
D	61.2	61	55	69
E	95.6	96	89	104
F	77.9	74	70	85

Which team had the greatest **range** of scores?

Answer Team _____

16 The sum of the interior angles (S) of a shape with n sides can be worked out using the formula:

$$S = (2n - 4) \times 90°$$

Work out the value of S when $n = 8$.

Answer _____ degrees

17 A bag contains 9 green marbles, 5 red marbles and some blue marbles.

The probability of picking out a red marble without looking is 0.25.

How many blue marbles are in the bag?

Answer _____ blue marbles

Go on to the next page

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18

A 1.6 mile length of road needs to be resurfaced.

The road is divided into sections.

Each section is $\frac{1}{5}$ mile long and takes one day to resurface.

How many days does it take to resurface the whole road?

Answer _____ days

19

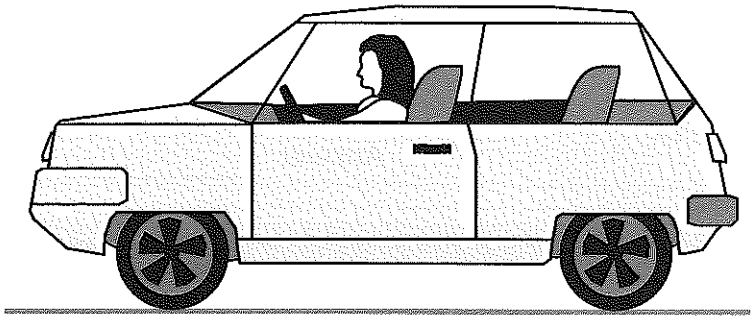
Rachel and Tom share some money in the ratio 3 : 2, with Rachel getting the larger share.

What are the two shares as percentages?

Answer Rachel _____ %

Tom _____ %

20



A car travels at an average speed of 30 miles per hour.

How many minutes would it take to travel 12 miles at this speed?

Answer _____ minutes

STOP: End of calculator section

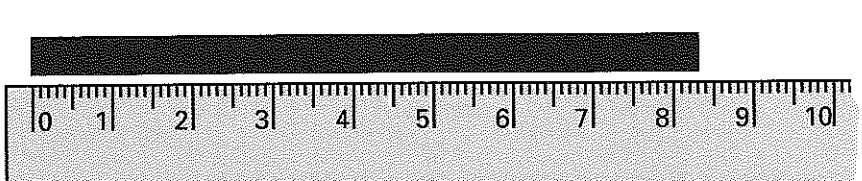
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Non-calculator section

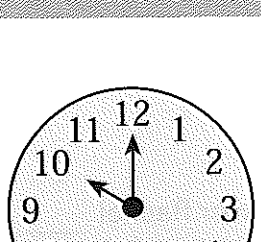
21 This diagram shows a ruler placed alongside a metal rod.

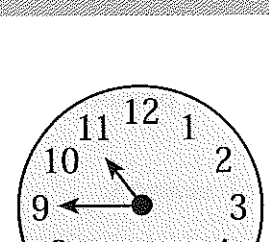


How long, in millimetres, is the rod?

Answer _____ millimetres

22





The minute hand of a clock turns through 3 right angles between 10.00 am and 10.45 am.

Through how many **degrees** does the minute hand turn?

Answer _____ degrees

23 Donna is working out values of y from values of x using this rule:

multiply the value of x by 5, and then add 3

What value of y should Donna get when x is 7?

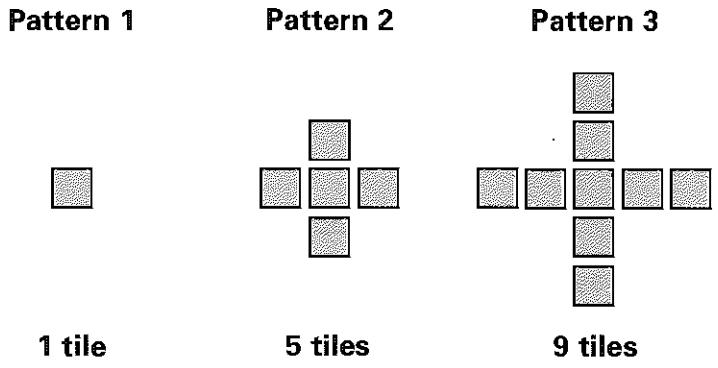
Answer _____

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24 Leela is making a series of patterns with tiles.



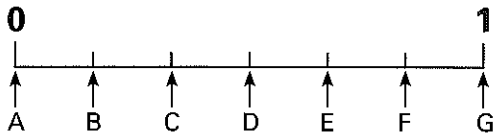
How many tiles will Leela need for Pattern 6?

Answer _____ tiles

25 Gavin has 10 coloured pencils in his pencil case – 5 yellow, 3 red and 2 blue.

He takes out one pencil without looking.

Which arrow on the probability scale below stands for the probability that the pencil he picked is a yellow one?



Answer _____

26 In sea explorations, distances below sea level are given negative signs.

A wreck is at –114 m.

A diving bell is at –75 m.

How much further, in m, does the diving bell have to go to reach the wreck?

Answer _____ m

Go on to the next page

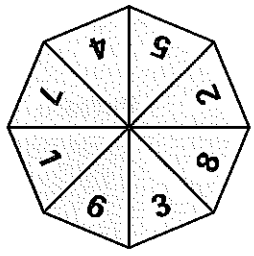
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27

Kay and Joe are making up rules for a game using this spinner which has the numbers 1 to 8 on it.



Write down in the box next to each rule whether Kay is **likely** or **unlikely** to win.

Rule A
If the spinner lands on 5, Kay wins.
Otherwise Joe wins.

Kay is _____ to win.

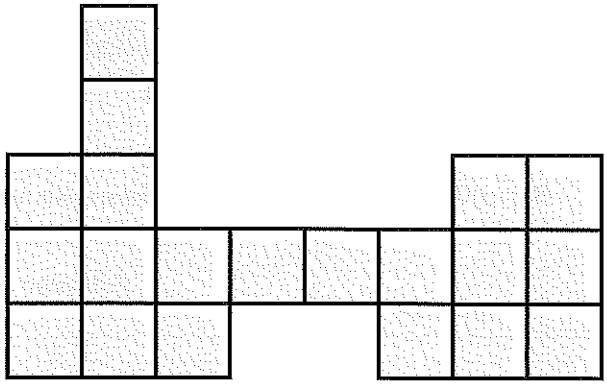
Rule B
If the spinner lands on a number smaller than 7, Kay wins.
Otherwise Joe wins.

Kay is _____ to win.

Rule C
If the spinner lands on a number which is a multiple of 3, Kay wins.
Otherwise Joe wins.

Kay is _____ to win.

28



Draw **one** line on this shape to show it split into two **congruent** parts.

29

A crate holds 18 bottles.

How many crates are needed to hold 666 bottles?

Answer _____ crates

Go on to the next page

Page total

30

2 5 7 12 19 ____ ____

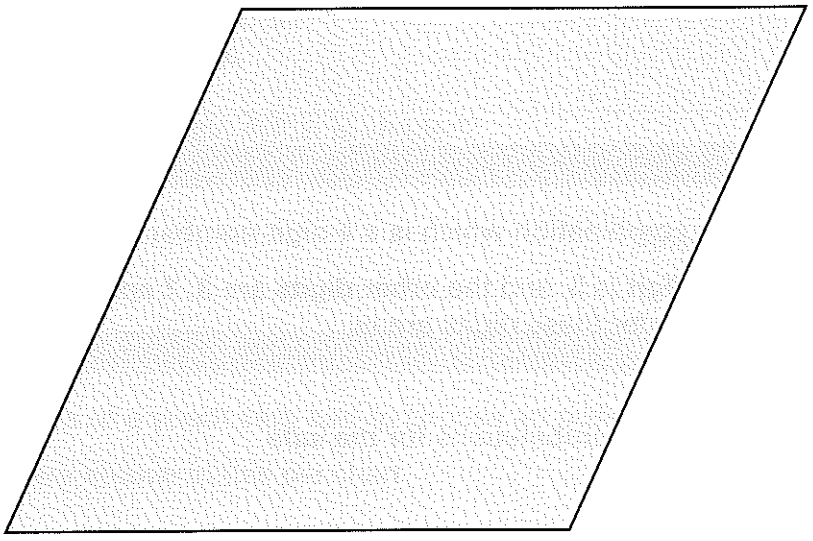
This number sequence begins 2, 5.

Then each following number is obtained by adding the two previous numbers together.

Write down the two numbers which follow.

31

Draw in the lines of symmetry on this rhombus.



32

In a box there are the following packets of crisps:

7 chicken
4 salt and vinegar
2 cheese and onion.

Anna takes out a packet without looking.

What is the probability that it is cheese and onion?

Answer _____

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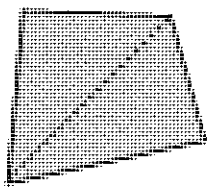
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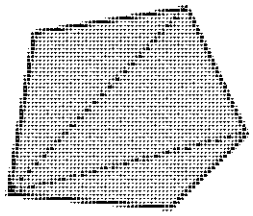
33

N stands for the number of sides of a polygon.

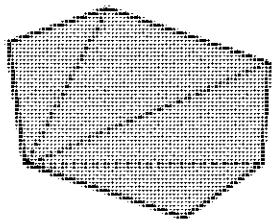
D stands for the number of diagonals that can be drawn from any vertex.



$N = 4$
$D = 1$



$N = 5$
$D = 2$



$N = 6$
$D = 3$

Using symbols, write down a formula that connects N and D.

Answer _____

34

Mrs Smith's safe has a combination which is a 4-digit number.

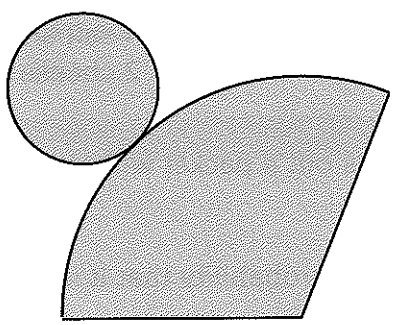
She knows the **second digit** is 5, and the **other digits** are 3, 7 and 8, but she is unsure what order these digits are in.

Write down **all** the possible combinations for the safe.

Answer _____

_____

35



This net can be made into a 3-D shape.

What would be the **name** of the shape?

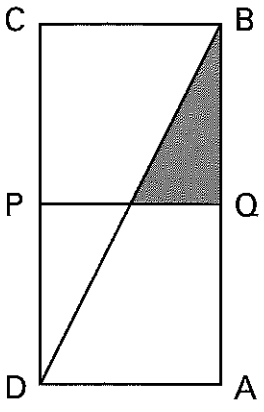
Answer _____

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Page total

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36 Look at this shape.



ABCD is a rectangle.

P is halfway between C and D.

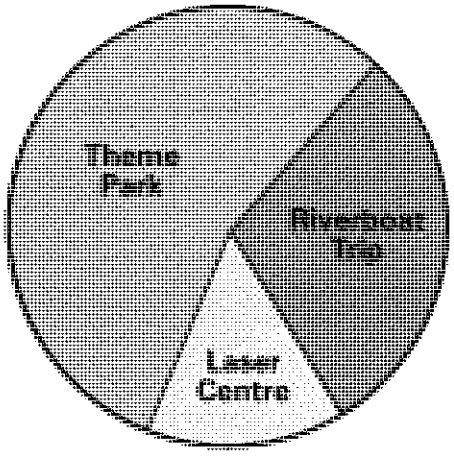
Q is halfway between A and B.

What **fraction** of rectangle ABCD is shaded?

Answer _____

37 Sixty members of a youth club had to choose an outing.

The results are shown in this pie chart.



Total = 60

About how many members chose the riverboat trip?

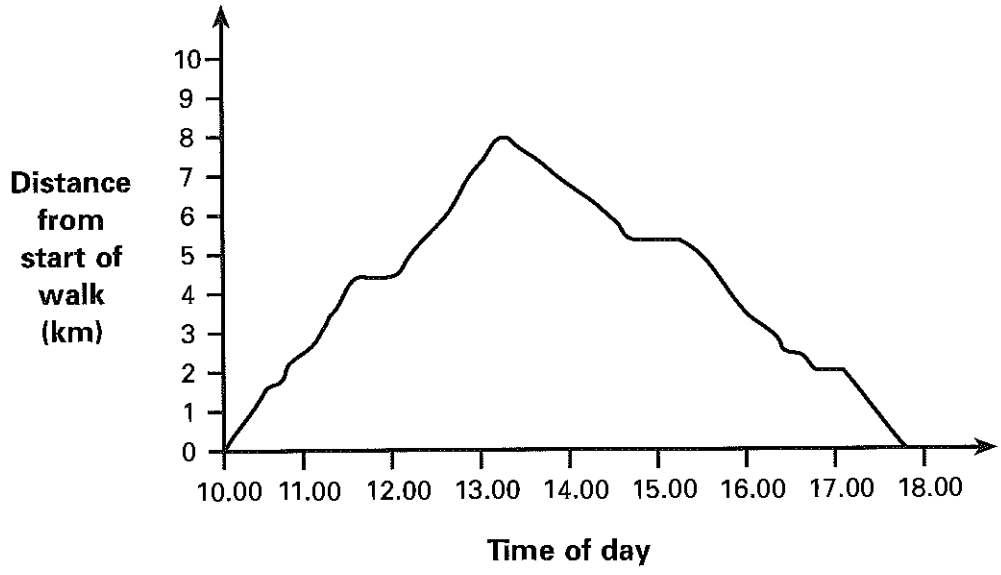
Answer _____ members

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Page total

38 This graph shows Jessica's journey on a sponsored walk.

She started at 10.00 and finished at 17.50.

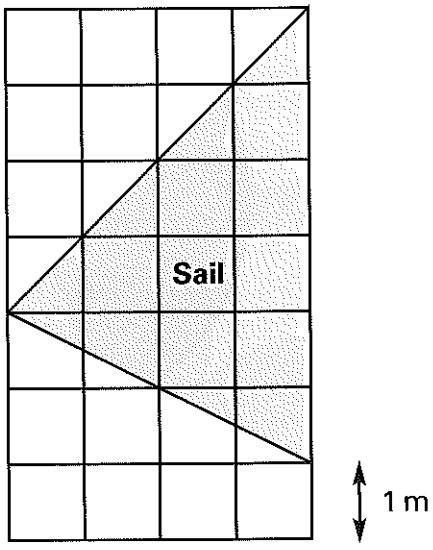


How far did Jessica walk?

Answer _____ km

39

The sail for a boat is cut out of a large piece of canvas marked out in square metres.



Work out the area of this sail.

Answer _____ m^2

Go on to the next page

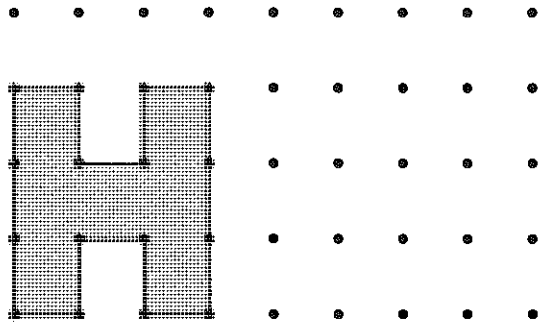
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Page total

40 What is 6.2 subtracted from 7.85?

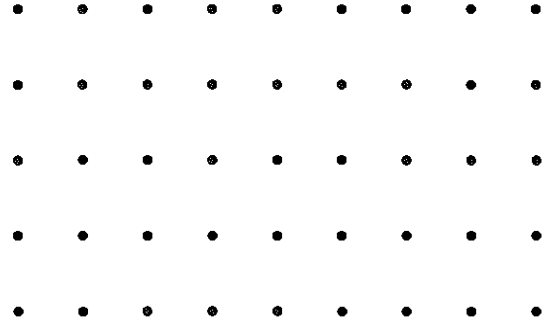
Answer _____

41 The diagram shows the letter H in a design for a poster.



The letter is transformed by multiplying the **width only** by a scale factor of 2.

Draw the outline of the transformed letter below.



42 Ashok is about to paint a fence.

He estimates that the area to paint is between 48 m^2 and 60 m^2.

Each tin of paint will cover between 4 m^2 and 6 m^2.

What is the **greatest** number of tins Ashok might use?

Answer _____ tins

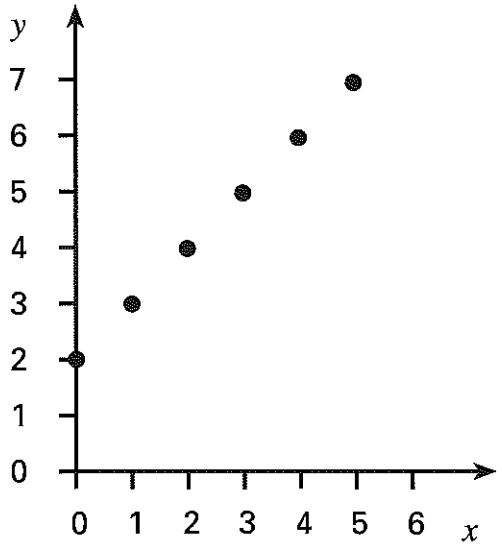
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43



Write down the equation of the straight line that would go through the points marked.

Answer _____

44

In each sentence below there is a number.

Round this number to **one significant figure.**

83 parents came to the school play.

Answer _____ parents

3824 people attended a football match.

Answer _____ people

289 people were inside the cinema.

Answer _____ people

Go on to the next page

Page total

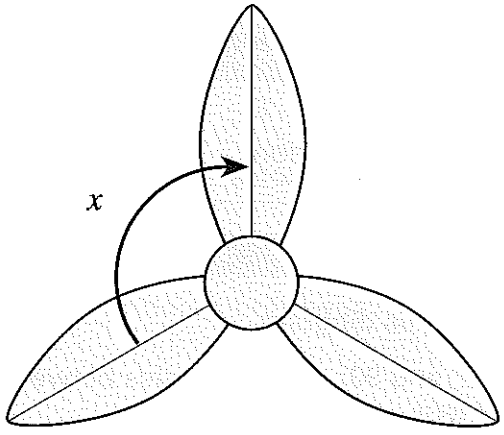
45 A farmer estimates that there will be 300 apples from every tree in the orchard.

x is the number of trees in the orchard.
y is the total number of apples from the orchard.

Write down an equation connecting x and y.

Answer _____

46 This propeller has rotational symmetry.



What is the size of angle x?

Answer _____ degrees

47 Denise has thought of two numbers.

The numbers added together make 23.

The smaller number subtracted from twice the larger number makes 22.

What are Denise's numbers?

Answer _____ and _____

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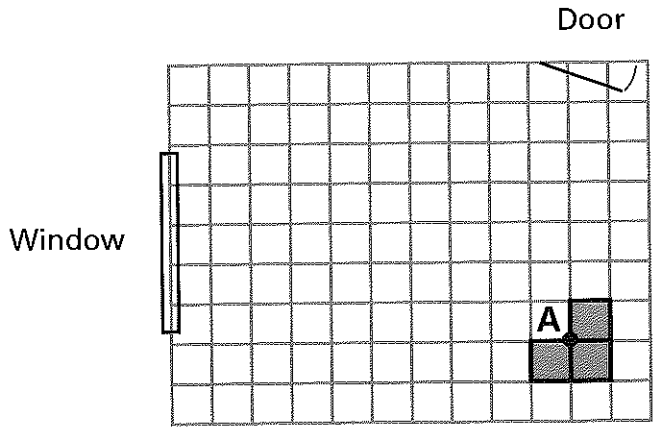
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48

Mr Johnson wants to move the television unit in his living room.





He rotates the television unit through 180° about point A.

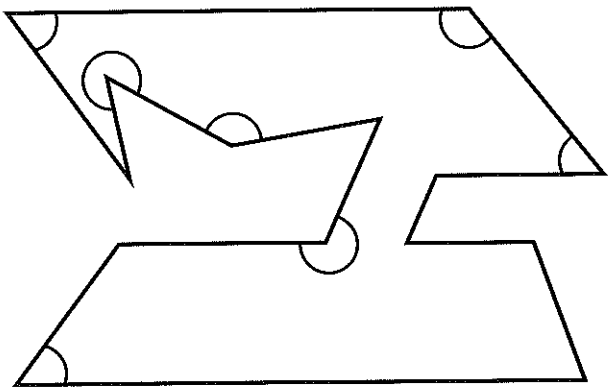
He then pushes it 5 squares towards the door and 8 squares towards the window.

Draw the television unit in its new position.

49

Several angles are marked in this diagram.

Acute angles are between 0° and 90°, obtuse angles between 90° and 180°, and reflex angles between 180° and 360°.



Do the following for each angle marked.

Put a ● in each acute angle,

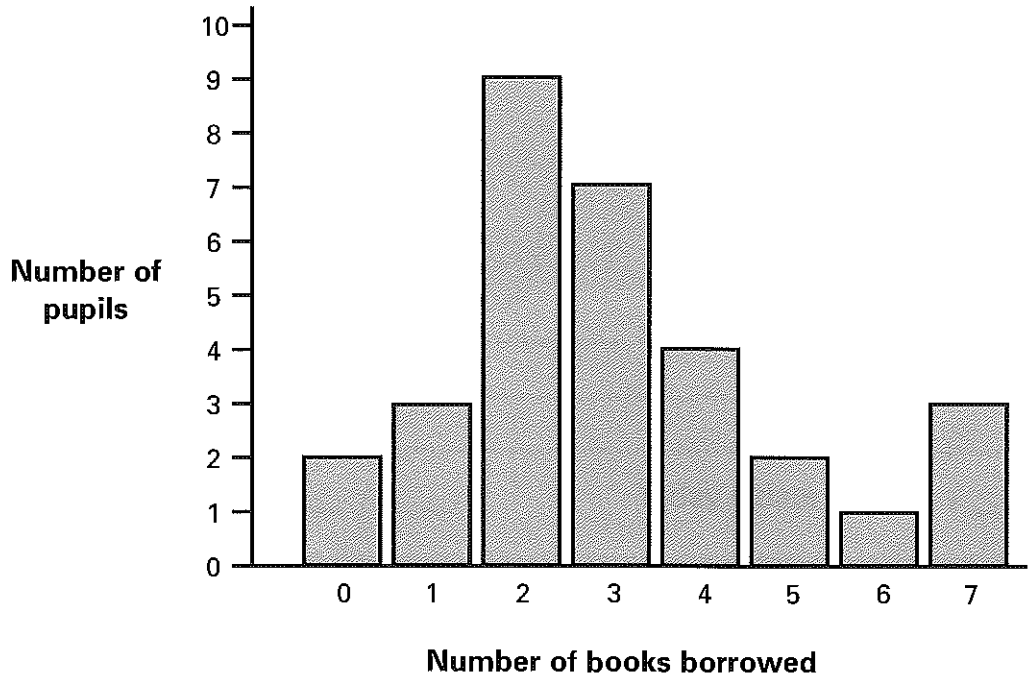
a ✕ in each obtuse angle,

and a ▲ in each reflex angle.

Page total

Go on to the next page

50 The pupils in Class 8G recorded the number of books they have borrowed from the library this term.



What is the **median number** of books borrowed?

Answer _____

What is the **modal number** of books borrowed?

Answer _____

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End of test

Page total

Comments

NFER-NELSON
Education
INFORMING YOUR DECISIONS

14

National Foundation for Educational Research

M A T H E M A T I C S

fourteen

First name ..... Surname ....2008.....

School .....

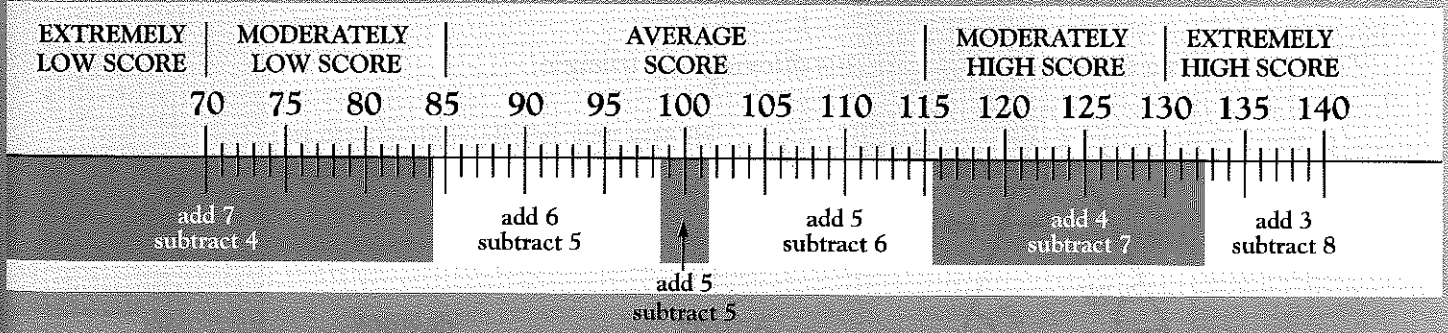
Class .....

Date of birth __ __ / __ __ / __ __ Today's date __ __ / __ __ / __ __

Note to Teachers

Fill in the boxes and mark the standardized score on the scale. Then add and subtract the numbers given for that region. Mark the interval with a broad horizontal line. This gives the 90 per cent confidence interval (you can be 90 per cent certain that the pupil's 'true score' is in this band). Full details are given in the Teacher's Guide on pages 16 and 19.

Age (years and completed months)	:	**Sex**		**Raw Score**		**Standardized Score**	
Percentile Rank		**Mathematics 13 Scale Score**		**Mathematics 14 Scale Score**		**Progress Score**	

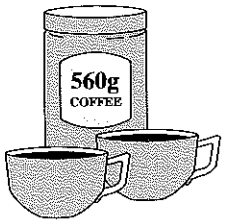


Comments

CALCULATOR SECTION

1

Lesley counted the number of cups of coffee she got from a 560g jar.
It came to 175 cups.



How many grams of coffee were used for each cup?

Answer _____ g

2

Work out the value of w by substituting $c = 15$ and $t = 8$ in the formula below:

$$w = c + 3.5t$$

Answer _____

3

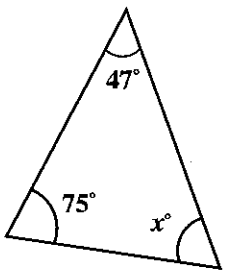
Calculate $\frac{1}{8}$ of \$52.

Give your answer in dollars and cents.

Answer \$ _____

4

Calculate the size of angle x in this drawing of a triangle.



Answer _____ degrees

Please do not write in this marg

Go on to the next page

5 The instructions to cook a chicken are 45 minutes for each kg, and then add 20 minutes.

How long, in minutes, will it take to cook a chicken that weighs 2.6 kg?

Answer _____ minutes

6 Write the correct number in the box.

$\frac{2}{5}$ of $\square$ = 64.

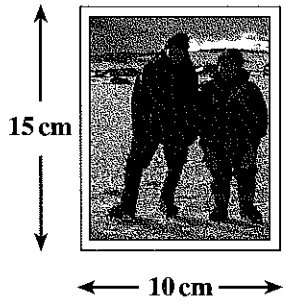
7 It costs $40 a day plus 35c a kilometre to hire a minibus from Barker's Minibus Hire.



How much does it cost to hire a minibus for 1 day and drive a total of 87 kilometres?

Answer $ _____

8 An enlargement of this photograph is made by multiplying each side by a scale factor of 4.



Work out the distance all the way around the enlarged photograph.

Answer _____ cm

Please do not write in this margin

Go on to the next page

9

A multi-pack of crisps has 20 packets with the following flavours:

10 plain
6 cheese and onion
4 salt and vinegar.

Kylie wants to construct a pie chart to show the frequencies of these flavours.

What angles should she draw at the centre of her pie chart for each flavour?

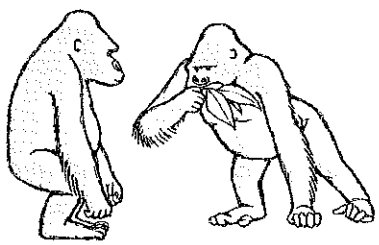
Answer Plain _____ degrees

Cheese and onion _____ degrees

Salt and vinegar _____ degrees

10

In a part of Africa, the number of gorillas has decreased from 250 to 110.



What is the **percentage decrease** in the number of gorillas?

Answer _____ %

11

A fruit drink is made from the juice of oranges, pineapples and grapes.
The ratios of orange juice to pineapple juice to grape juice are 5 : 2 : 1.

What percentage of the fruit drink is pineapple juice?

Answer _____ %

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12 The average rainfall in five cities for 1 week was 45 mm.
This table shows the amount of rain in these cities.



Fill in the missing number.

Cardiff	☐ mm
London	20 mm
Belfast	38 mm
Dublin	72 mm
Edinburgh	43 mm

13 Barbados is an island in the Caribbean Sea.
The population of Barbados is 260 000 in an area of 430 km².



Work out the number of people for each km².
Give your answer to the nearest whole number.

Answer _____ people for each km².

14 The table below shows the number of full buckets of different sizes needed to fill a 900 litre tank.



Fill in the missing value in the table.

Size of bucket (litres)	10	15	20	25
Number of full buckets	90	60	45	

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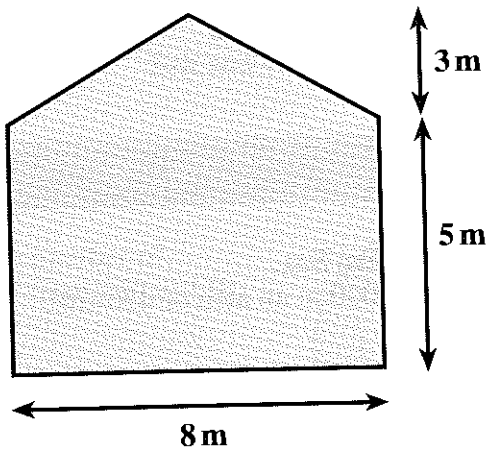
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15 Each number in this sequence is 90% of the previous number.

10 000 9 000 8 100 _____ _____

Write in the next two numbers in the sequence.

16 This diagram shows the end wall of a house.



What is the **area** of the wall?

Answer _____ m^2

17 107 passengers went on an outing in two full coaches and a full minibus.
Later, 76 passengers went in one full coach and two full minibuses.

How many passengers does a coach hold?

Answer _____ passengers

Please do not write in this marg

Go on to the next page

18

John did a survey of the pupils in his class to find out the amount of milk their families buy each week.
This table shows the number of litres that 30 families buy.

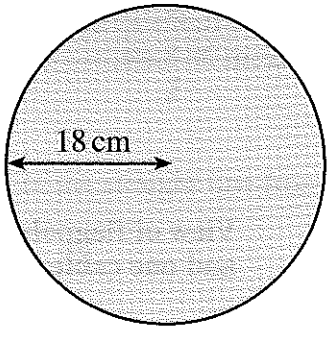
Number of litres	Number of families
5	1
6	4
7	6
8	10
9	7
10	2

What is the **mean** number of litres per family?
Give your answer to one decimal place.

Answer _____ litres

19

The base of a circular tray with a radius of 18 cm is to be painted.



What area, in cm^2, is to be painted?
You should use the formula for the area of a circle with the value of π as 3.14.

Answer _____ cm^2

Please do not write in this margin

Go on to the next page

20

When $x = 2$, $x + 4$ is bigger than x^2.
When $x = 3$, $x + 4$ is smaller than x^2.

Find the value of x to **one decimal place** for which $x + 4$ is **closest** to x^2.

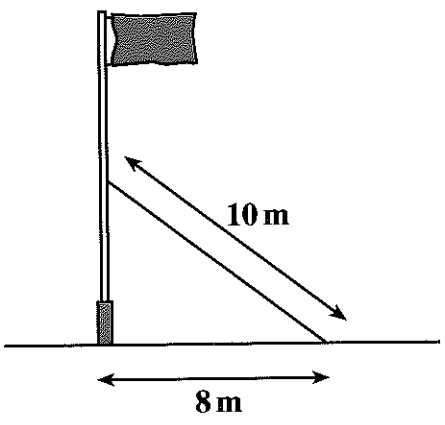
You may use this table.

x	$x+4$	x^2
2	6	4
3	7	9

Answer $x =$ _____

21

A flagpole is kept vertical by steel cables, each 10 m long. One end of each cable is joined to the flagpole **halfway** up, and the other end to the ground 8 m away from its base.



View of flagpole and one cable

Not to scale

Use Pythagoras' theorem to work out the height of the flagpole.

Answer _____ m

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22

A solid cuboid is made of metal.
It measures 8 cm by 5 cm by 2 cm, and weighs 380 g.

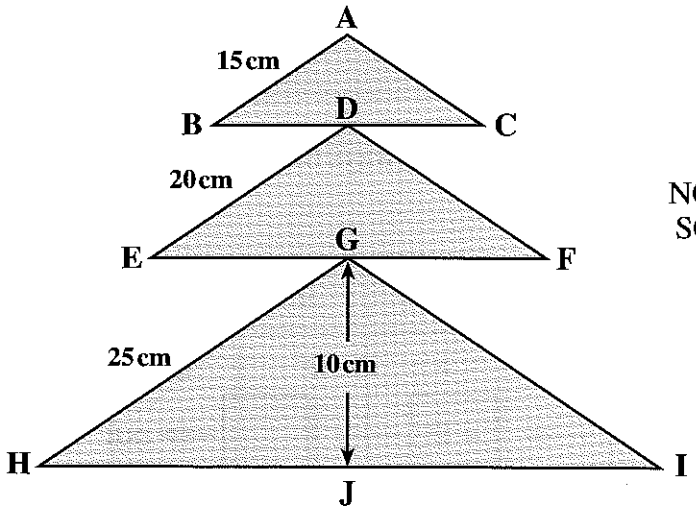
Calculate the weight of 1 cm^3 of the metal.

Answer _____ g

23

A Christmas decoration has a frame which is made from three wire triangles.
The triangles are the same shape but different sizes:

AB = 15 cm DE = 20 cm GH = 25 cm GJ = 10 cm



NOT TO SCALE

Work out the length of the straight line from A to J.

Answer _____ cm

24

A tiny object has a length of 4×10^{-4} cm.

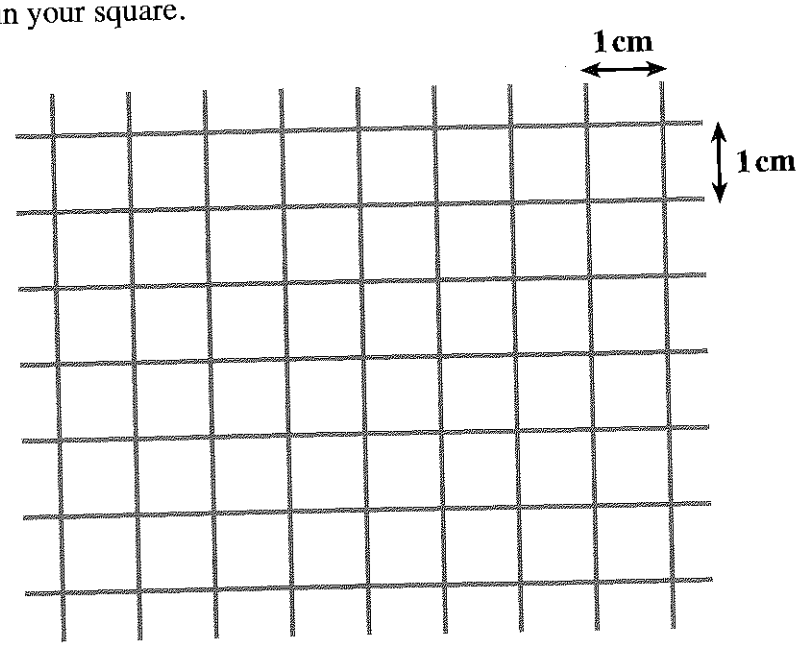
How many of these objects would measure **exactly** 1 cm when placed end to end?

Answer _____ objects

STOP: END OF CALCULATOR SECTION
Please do not continue until you are told to do so

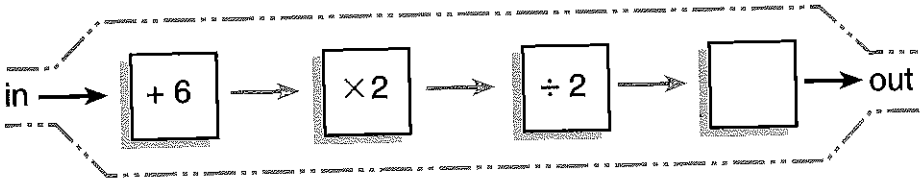
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25 On the grid below draw a **square** with a perimeter of 20 cm.
Shade in your square.



26 The number that comes out of this machine is **always** the same as the number that goes in.

Fill in the empty box.



27 Fourteen counters are put into a bag.
3 are white, 9 are red and 2 are green.
Gary takes out one of the counters without looking.

Write **no chance** or **poor chance** or **even chance** or **good chance** to show the probability of Gary getting a counter of the following colours.

Answer Green _____

Yellow _____

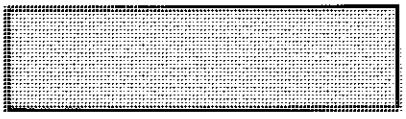
Red _____

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28

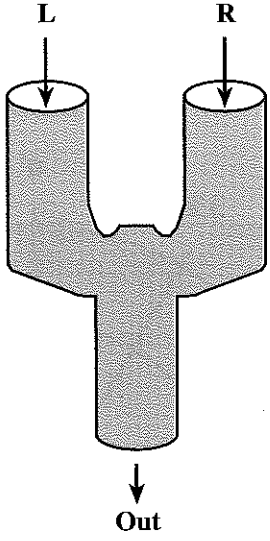
Work out the **area** of this rectangle.



Answer _____ cm^2

29

The numbers put into this machine are combined and come out as a single number.



The table shows what has happened for some numbers.

Complete the last line of this table.

L	R	Out
2	4	4
3	9	23
4	5	16
8	7	

30

Satish drinks one 250 ml carton of orange juice every day.

How much orange juice did he drink in total during the 31 days of January?
Give your answer in millilitres (ml).

Answer _____ ml

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31

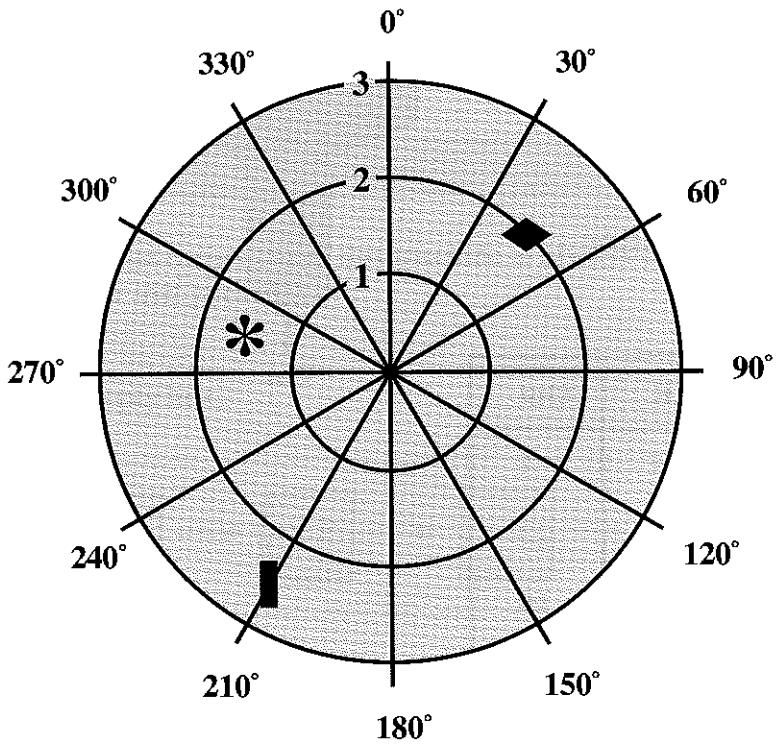
At the corner shop the labels have come off 40 tins of soup.
27 of the tins are tomato, 8 are chicken and 5 are mushroom.
Pat buys a tin.

What is the probability that the tin is chicken?

Answer_____

32

The diagram below shows the screen in a computer game.



◆ is at (45°, 2)

▮ is at (210°, 2.5)

At what position is ✻?

Answer_____

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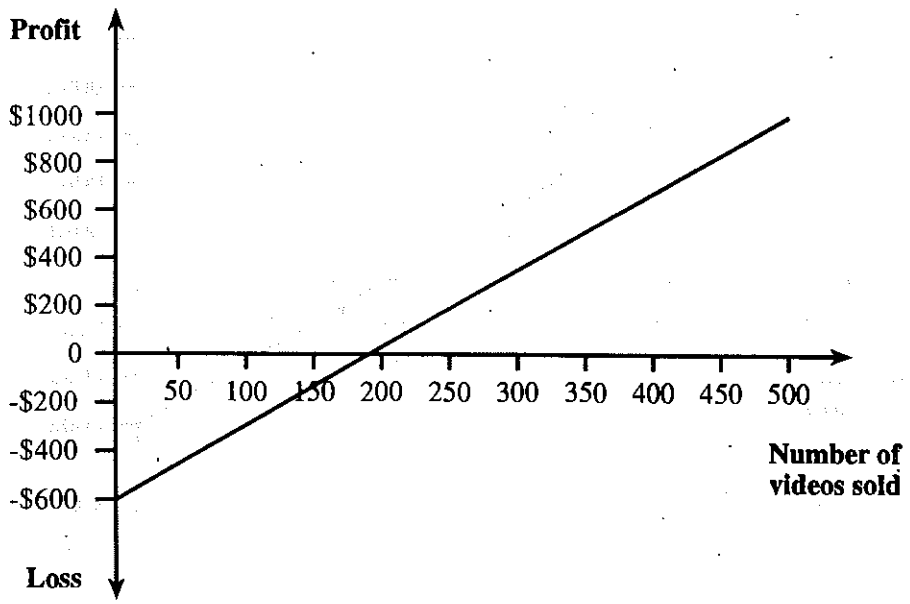
33 Work out an **approximate value** for $802.6 \div 3.8$ by rounding 802.6 to the nearest ten and 3.8 to the nearest whole number.

Answer _____

34 Write the missing word in the box.

π = circumference ÷ [ ]

35 The graph shows how much profit or loss a video shop makes each week for the number of videos sold.



About how much profit is made if the shop sells 400 videos?

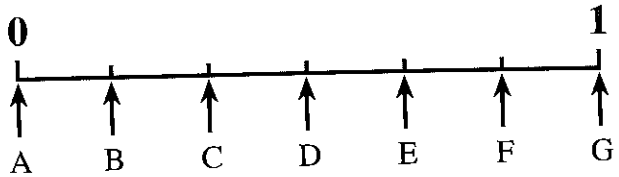
Answer $ _____

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36 Adam has 12 coloured pencils in his pencil case - 6 green, 4 red and 2 blue.
He takes out one pencil without looking.

Which arrow on the probability scale below stands for the probability that the pencil he picked is a red one?



Answer _____

37 $6x + 9 = 8x$

Work out the value of x.

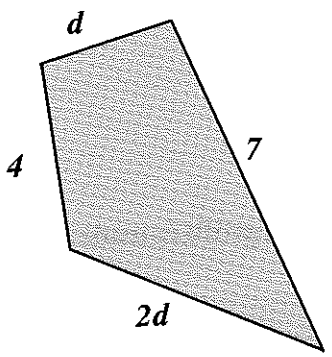
Answer _____

38 Tara is working out the thickness of some sheets of paper.
She has found that the thickness of 100 pages of a book is 4mm.

Work out the thickness, in mm, of 1 page.

Answer _____ mm

39 Write an expression for the perimeter of this shape, as simply as possible.



Answer _____

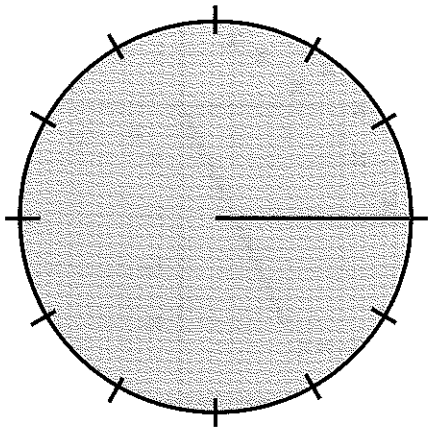
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40

There are 30 pupils in Class 9R.
15 live in houses, 10 in flats and 5 in bungalows.

Complete the pie chart below to show this information.



41

At a holiday activities centre, you can choose one of these activities in the morning and one in the afternoon.

Morning	**Afternoon**
Aerobics	Tennis
Horse-riding	Water-skiing
Go-kart racing	Snorkelling
Rock climbing	Windsurfing
Abseiling	

How many different combinations of activities are possible?

Answer _____ combinations

42

A straight line joins the point (4, 6) to the point (10, 18).

What are the coordinates of the mid-point of the line?

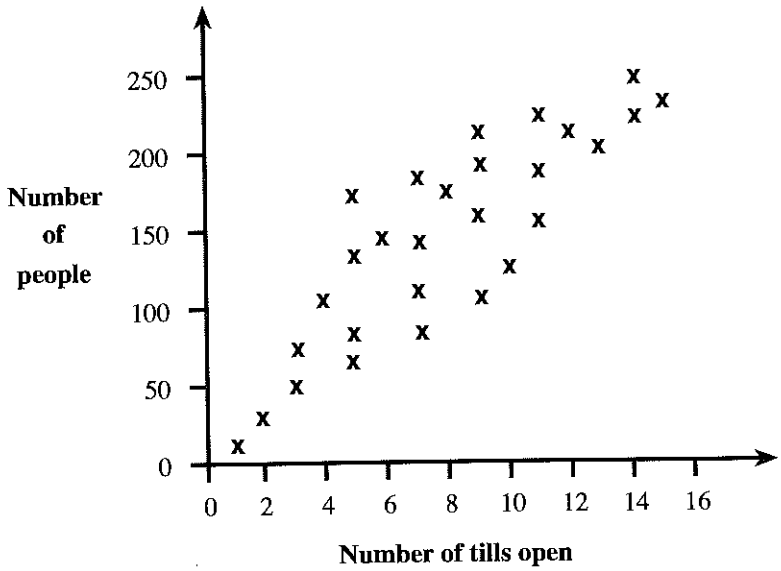
Answer _____

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43

The number of people and the number of tills open in a supermarket were recorded four times a day for a week.
The scatter graph shows the results.



How is the relationship shown in the scatter graph **best** described?
Tick your answer.

Good positive correlation	
Slight positive correlation	
No correlation	
Slight negative correlation	
Good negative correlation	

44

At a cafe, beans on toast cost $1.60.
The beans cost 70c **more** than the toast.

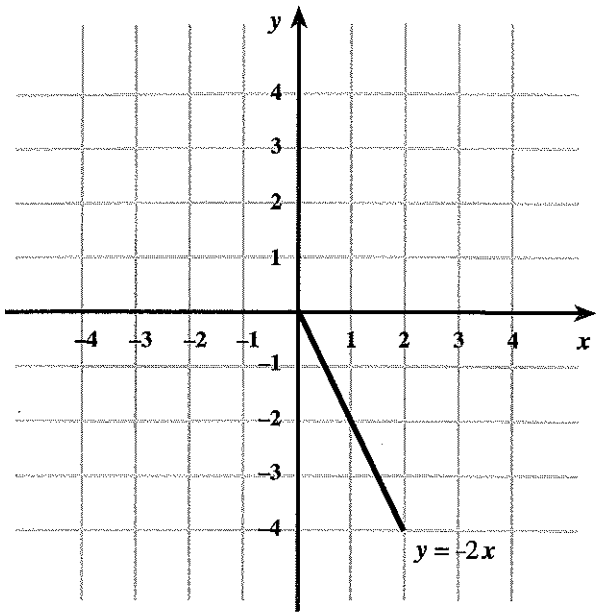
How much does the toast cost?

Answer _____ c

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45

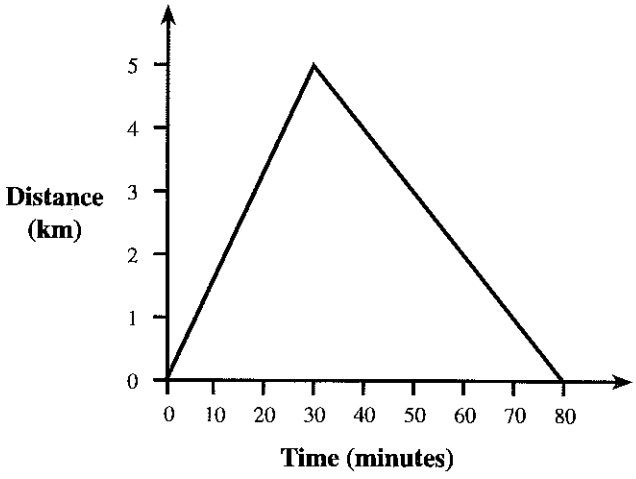


On the grid, the graph of $y = -2x$ is shown for values of x between 0 and 2.

Sketch on the grid the graph of $y = -2x$ for values of x between -2 and 0.

46

The graph shows the journey of a boat sailing from a harbour to a buoy 5km away, and then back again.



What was the average speed of the boat from the harbour to the buoy?

Answer _____ kilometres per hour

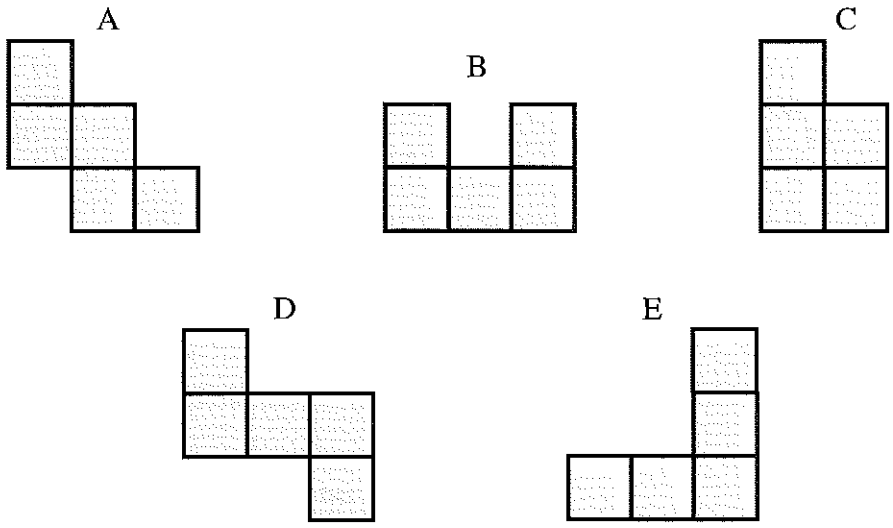
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47

Only two of these nets can be folded up to make boxes **without** lids.

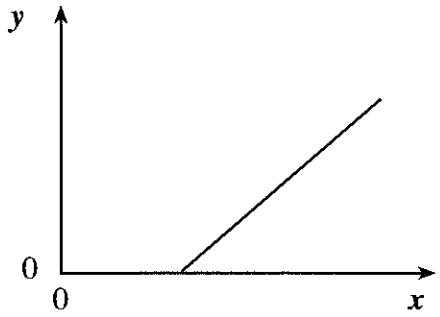
Which nets are they?



Answer Net _____ and net _____

48

Look at this graph.



Which one of these could be the equation of the graph?
Circle your answer.

A $y = x^2$ **B** $y = x - 2$ **C** $y = x + 2$

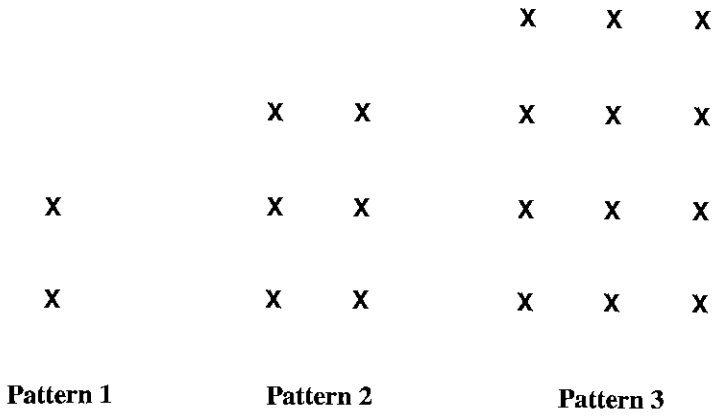
D $y = 2x$ **E** $y = \frac{x}{2}$ **F** $y = 2 - x$

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49

Here are the first three patterns in a sequence.



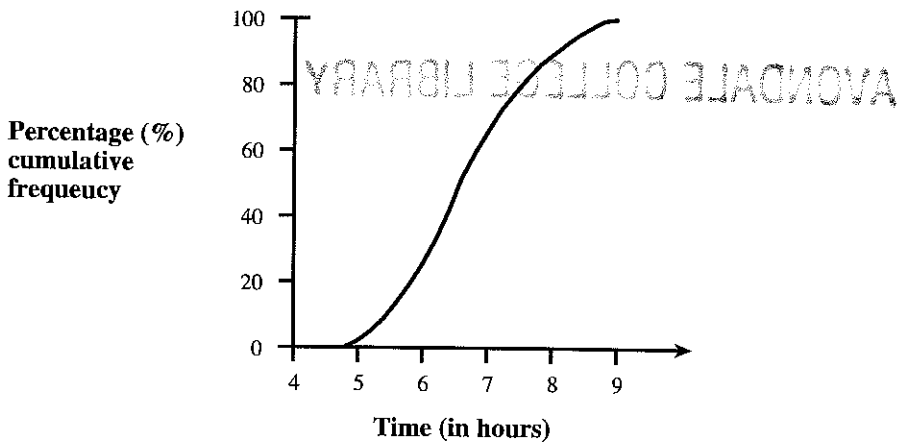
Pattern 1 **Pattern 2** **Pattern 3**

How many crosses are there in **pattern number *n***?

Answer _____ crosses

50

500 runners completed a long distance race.
The percentage cumulative frequency graph below shows the results.



Judy finishes in 125th place.

How long did it take her to complete the race?

Answer _____ hours

End of test

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